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PLATE I

EXPLANATION OF PLATE I.

The Cabbage White Butterfly (Pieris brassicæ).

Fig. 1. A cabbage leaf on which are seen (a) a batch of eggs, (b) a group of newly-hatched caterpillars, and (c) seven caterpillars in a more advanced stage of growth.

„ 2. A single egg. × 15.

„ 3. A full-grown caterpillar. × 2.

„ 4. A pupa. × 2.

„ 5. A male butterfly. × $\frac{3}{2}$.

„ 6. A male butterfly with wings closed. × $\frac{3}{2}$.

THE CABBAGE WHITE BUTTERFLY (PIERIS BRASSICÆ).

By T. BAINBRIGGE FLETCHER, R.N., F.E.S., F.Z.S.,
Officiating Imperial Entomologist.

To those of us who have been in Western lands, the House Sparrow and the Cabbage White Butterfly are amongst the best known of the denizens of the air. The sparrow, which well deserves its title of "the avian rat," is pre-eminently a town-dweller and is almost as essential a feature of the population of our Indian cities and towns, as it is in the streets of London. The Cabbage White Butterfly, though of course primarily an inhabitant of gardens and open spaces, is yet one of the commonest and most familiar of the insects included in the scanty list of those known by name to the veriest Cockney. The new arrival from Europe accepts the occurrence of sparrows and rats in India more or less as a matter of course, but the insects seem so much more varied and so different from those to which he has been accustomed, that an old acquaintance like the Cabbage White Butterfly probably passes unnoticed and unrecognized. It is true that this insect is not widely distributed in the plains of India; nor does it occur at all times of the year. As in Europe, it is a true harbinger of Spring, and its presence in our compounds tells us that another hot weather is before us.

In Central Europe this butterfly usually completes two life-cycles in the year, appearing on the wing in Spring and late Summer, but in the southern limits of its range along the Mediterranean Seaboard there may be three or four broods, the butterfly being found almost continuously at any season. There seems to be very little information regarding the number of broods

which occur in any part of India, but apparently it breeds continuously during the warmer weather, all along the Himalayas from Chitral to Bhutan, and there may be two, three or more generations annually according to the climatic conditions of any particular locality. It is curious that it has rarely been recorded from the plains of India, except from the neighbourhood of Umballa, where Captain Lang noted its abundance in January. In Behar, the Cabbage White Butterfly is usually abundant at Pusa in March and April, its numbers varying considerably in different years; apparently there is only one brood, as the butterfly is never seen in any stage except at this time of the year.

We know that the butterfly does not occur in the neighbourhood of Pusa from June to December, but that it is found regularly every year between January and May. How can this regular but intermittent appearance be explained? There seems to be little doubt but that we are dealing with a case of migration, and that the caterpillars found on our cabbage in March, are the offspring of butterflies which were reared in the hills and which have migrated down into the plains, about January, to lay their eggs. As a matter of fact, the migrant habits of this particular butterfly are well known and have often been recorded, the arrival on the South Coast of England of large flights from across the Channel having been noted by many observers.

The seasonal migrations of butterflies have frequently been observed in India, and more particularly in Ceylon, and the sight of an apparently endless stream of butterflies, all following one direction, pushing in an impetuous flight across country during the hottest part of the day and usually hurrying along directly against the wind, cannot fail to attract the attention of the most casual observer. The questions which present themselves to one's mind in connection with these flights form a fascinating subject of inquiry, but we cannot now pursue this theme further, although we may note, in passing, that the seasonal migration-flights of butterflies are as a rule composed almost wholly of individuals of various species which belong to the great family of "White" Butterflies (*Pieridæ*).

We see then that there is a reasonable degree of probability in the theory that the Cabbage White Butterflies which suddenly appear in our compounds in the Spring are immigrants from the hills or descendants of such immigrants. Whether there is any return flight, whether any of those individuals which have been bred in the plains ever find their way to the hills, is a matter of doubt, but it seems highly unlikely that they do so. They appear to linger on in the plains, gradually becoming fewer and fewer in number until no more are noticed, and there does not seem to be any marked congregation of individuals or general direction of flight such as would be expected in the case of a true re-migration. So far as concerns the propagation of the species then, the migration into the plains appears to be quite useless.

So many reams of matter have been written on the life-history of this well-known butterfly that it seems superfluous to describe it here in minute detail. The coloured plate shows the life-history as worked out in the Insectary at Pusa. In the centre is a cabbage-leaf showing a batch of the small yellow eggs, of which a single one is shown more highly magnified in the right-hand upper corner of the plate. Opposite the eggs is seen a cluster of the newly-hatched caterpillars, which are gregarious when young, and whose first meal is composed of the empty egg-shells from which they have emerged; later on in life, they separate, and eat practically the whole of the leaf, as is shown lower down in the plate. To the left is seen a full-grown caterpillar (twice the natural size) which wanders away from the plants and affixes itself to any convenient upright object, fastening itself by a pad of silk at the tail-end and a silken girdle, and then transforms into a pupa, from which the butterfly emerges after a period of seven or eight days. The butterfly figured in the plate is a male, the female being distinguished by the presence of two large black spots and a black dash on the forewing.

In Europe the life-history has lately been worked out in detail by Martelli (Boll. Lab. Zool. Portici, Vol. I, pp. 170—224), and reference may be made to this work by those

interested in full details. De la Garde's note on the egg-laying habits of this butterfly should also not be overlooked (Entom. Record, Vol. XVII, p. 243). The number of eggs counted by Martelli, in fifty batches, varied from a minimum of 18 to a maximum of 248; the maximum number found in a cluster at Pusa is 74. The life-cycle, as worked out at Pusa, is about a month during the hot dry weather of April and May. The following table shows actual periods of four specimens:—

No.	Eggs laid.	Eggs hatched.	Larva pupated.	Butterfly emerged.	Period in days.
1	31st March.	4th April.	21st April.	28th April.	28
2	1st April.	5th ,,	20th ,,	29th ,,	28
3	4th ,,	8th ,,	24th ,,	3rd May.	29
4	13th ,,	17th ,,	3rd May.	10th ,,	27

The damage done to cabbages and cauliflowers by the caterpillars of this butterfly may be very great. In India it has also been reported as attacking gram (*Cicer arietinum*), linseed (*Linum usitatissimum*) and sugarcane (*Saccharum officinarum*). The most practical remedy, as a rule, is the picking off and destruction of the egg-masses and caterpillars, particularly of the clusters of young caterpillars before these have separated.

When being shown an insect of any sort, the average member of the general public is very apt to ask what its use may be. Needless to say, this is a question to which we are generally unable to give any reply. I believe that at one time an attempt was made to utilize the caterpillar of this butterfly in the dyeing trade, and that cloth dyed "Chenille Green" by the aid of crushed caterpillars enjoyed an evanescent popularity. The discovery of aniline dyes, however, speedily put an end to this industry, if so it may be called.

THE SEVENTH MEETING OF THE BOARD OF AGRICULTURE.

By J. H. BARNES, B.Sc., F.I.C., F.C.S., A.R.I.P.H.,
Principal of the Agricultural College, Lyallpur, Punjab.

THE seventh meeting of the Board of Agriculture was held this year at Pusa from the 20th to 25th of November 1911, the President being Mr. Bernard Coventry, the Officiating Inspector-General of Agriculture in India. There were 29 members and 28 visitors present, among the latter being the Hon'ble Members of Council for Revenue and Agriculture and Commerce and Industry, Mr. (now Sir) Robert Warren Carlyle, C.S.I., I.C.S.: and Mr. W. H. Clark, C.M.G. (now C.S.I.), who attended during the 5th day of the Board's Proceedings, when the subject of the Indian Sugar-cane Industry was under discussion. Mr. W. H. Moreland, C.I.E., I.C.S., though no longer attached to the Agricultural Department, very kindly attended the Board, at the President's request, for the purpose of placing at its disposal his wide and extended experience of this industry in the United Provinces.

It will perhaps be remembered that the last meeting of the Board was held at Pusa in February 1910, when it was decided for the future to hold the meetings biennially instead of annually. This would have caused the seventh meeting to fall in the Spring of 1912. The Inspector-General, however, found that the accumulation of work necessitated a meeting before this date, and consequently the members were summoned some months earlier.

The seventh meeting of the Board marks a new stage in the history of the Indian Agricultural Department and its work for several reasons. In the first place, an effort has been made

to emphasize particularly one important branch of Indian agricultural industry, to collect all the available information on this subject and to see how far improvement can be effected. The past meetings have shown more and more this growing tendency to specialisation, and we can almost safely prophesy that future meetings of the Board will be called together to discuss fewer and fewer subjects on account of the increasing mass of detail to be considered and co-ordinated. The meeting for the year 1911 will be remembered as the "Sugar Board," for the present condition of this industry and the possibilities of its improvement constituted the main subject of discussion. The increasing information available from members on the various subjects under consideration, and the deeper knowledge of local problems, was also a noticeable feature of this year's meeting. This natural outcome of wider experience on the part of the Board's members will be gratifying to readers of the Agricultural Journal as indicating that the Agricultural Department is now getting into its stride and that the strenuous efforts of the past years are beginning to take effect in every aspect of its work.

These meetings not only serve the purpose of a free exchange of experience and opinion between the members of the department drawn from all parts of India, but they provide a stage from which to look back on the objects and accomplishments of past work and to look forward to the planning of future enterprise.

It is to be regretted that these stages have had to be lengthened out to two years by reason of the demands which such meetings make on the time of the members, and we can only look forward to the time when increased staff and extended organisation will allow more liberty to the senior officers of the department for this most important work.

The agenda sheet was divided into the following thirteen subjects :—

(I) The confirmation of the minutes of the last meeting.

(II & III) The Programmes of work of the Imperial and Provincial Departments of Agriculture.

(IV) The best means of bringing the results of experimental work to the notice of cultivators.

(V) Manures—

(*a*) The most economical manures available in India and the experience gained in their use.

(*b*) The conservation and application of cattle manure.

(VI) The Oil-pressing Industry and the best means of extending it.

(VII) Opening the proceedings of the Board to the Press.

(VIII) The granting of honorary degrees of L. Ag. to such diplomates of old Agricultural Schools and Colleges as have done work of exceptional merit, and to non-officials whose interest in, and services to agriculture, are conspicuous.

(IX) The duties of Agricultural Associations in India.

(X) The general lines on which the organisation of scientific research in the Provincial Departments of Agriculture should be developed.

(XI) The maintenance of pure seed of improved varieties of crops.

(XII) The Sugar Industry—

(*a*) The improvement of the indigenous industry;

(*b*) the production of refined sugar which is now imported;

(*c*) the possibilities of extending the area under sugar-cane in India.

(XIII) Cotton investigation in India and the note thereon by the Inspector-General of Agriculture in India.

The proceedings were opened by the President, who asked the Board to place on record an expression of regret at the absence of Mr. J. Mollison, C.S.I., M.R.A.C., and of appreciation of the great and lasting services he had rendered to Indian Agriculture and to the Indian Agricultural Department. This was universally approved. Reference was also made to the loss felt by the Board of Messrs. Couchman, Renouf, Keatinge, MacKenna and Gourlay, owing to the expiry of their term of office as Directors of Agriculture.

The minutes of the last meeting, held at Pusa on February 21st, 1910, were read and confirmed, and the President handed over the agenda in detail to committees of members for report. This method of clearing the ground work of discussion has been in practice at the last four Boards, and is found to be most useful in economising time.

Subjects II & III.—With some minor alterations and additions the programmes of work for the Imperial, Provincial and Native States' Departments of Agriculture were confirmed by the Board. As regards the first, it was decided that the importance of a more detailed knowledge of the relative feeding values of food-stuffs and fodders for cattle merited an early study of the subject at Pusa. Space does not permit of going into the details of these programmes, and as many of the readers of the Agricultural Journal are familiar through its pages with the general work of the departments it is perhaps unnecessary.

Subject IV.—At the three meetings of the Board previous to this, a special committee has reported on the subject of the best means of bringing the results of experimental enquiry by the Agricultural Department to the notice of the cultivating classes throughout India. The work of these committees has been embodied in two reports, which are largely a collection of instances of success in method and application. These methods were classified and discussed under the following headings—

(*a*) *Agricultural Associations.*

It was not felt by the Board that Agricultural Associations were realising the expectation of the past. In some parts of India they have been a success, whilst in others they are a failure, notwithstanding the expenditure of a considerable amount of time and trouble on them. In consideration of these facts, the duties of such associations formed a separate subject for discussion at the Conference and will be referred to below.

(*b*) *Local Demonstrations.*

Considerable development in methods and results was reported on the organisation of local demonstrations for the

popularisation of agricultural improvements. In some cases these demonstrations have been carried out on the departmental farms, in others on private farms. Such improved implements as improved ploughs have had their merits emphasised by organised ploughing matches in which prizes are given for the best work. The general report from all departments is that this side of departmental work has outgrown the staff available for it. Not only are more assistants in agriculture of the Agricultural College graduate standard required, but a need is being felt for more well-trained fieldmen also.

(*c*) *Vernacular Agricultural Journals, Leaflets and Circulars.*

Popular and illustrated journals of this type are on the increase and in some cases have their financial stability guaranteed by local agricultural associations. Such journals are considered to be of great use, as they penetrate to the remotest villages where at least a portion of the agricultural community can read and write. In some cases the editing of these journals is done by members of the Agricultural Department, and in all cases the successful methods of the Agricultural Department find recognition.

(*d*) *Agricultural Shows and Exhibitions.*

Gradually extended use is being made of existing large shows and *melas*, and the Board, in recognising the value of agricultural demonstrations, etc., at such shows, recommend (1) that the prizes given should be limited to a few crops of importance and which present reasonable hope of improvement: (2) that the showing of stock be encouraged: and (3) that the practical demonstrations of machinery, implements and methods are essential to success, but they should be limited to those suitable to the district in which the show is being held.

(*e*) In a number of provinces useful work is being done by itinerant assistants.

(*f*) *Short vernacular courses, in special subjects, for cultivators and their sons.*

The evidence before the Board showed that the time had already come when expansion in this direction could be commenced. There seems little doubt, but that this will ultimately prove to be the most popular side of the educational work of the department. Courses have already commenced in some provinces and at Pusa. It is important to bear in mind that such instruction must be practical and to the point, and must be organised and carried out with the same care that is given to higher education.

(*g*) It is felt that in the introduction of new varieties of seed, assistance in marketing the produce is often essential to success in the earlier stages. This has proved to be the case in the introduction of "Buri" cotton in the Central Provinces and "Broach" cotton in Dharwar.

(*h*) *Connection with the Co-operative Credit Movement.*

Little has been done in this direction up to the present, but the Board were emphatically of the opinion that a close relationship between the Co-operative Credit movement and the Agricultural Department's work of improvement gave great promise of success and was in every way desirable

Subject V.—In considering the most economical manures available in India, two main points received particular emphasis. In the first place the use of artificial manures is at present limited to certain tracts, where such valuable and special crops as tea, coffee, etc., are grown. A considerable amount of further information will yet have to be obtained, from the departmental experimental farms, as to the applicability of artificial manures to Indian soils and crops before their use can be economically extended. At the present time cattle manure appears to be the most economical natural manure in this country and so much is this recognised that its conservation formed the subject of a special discussion. Secondly, the practice of ploughing in a green crop as a fertiliser appears to be a manurial method of particular value in Indian agriculture, not only on account of the accumulation of plant food, which results, but also because of the improvement of the "condition"

of the soil and the increase in its moisture-retaining powers, a point of particular value in an arid climate such as exists in many parts of the Peninsula. A wider knowledge of the biological, physical and chemical effects resulting from the practice of green manuring cannot but lead to the extension of what promises to be one of the best and most suitable methods for increasing and maintaining the fertility of Indian soils, and the Board consequently recommended the extended study of this practice.

In considering the best methods for the conservation and application of cattle manure, the Board were unable to make any useful recommendation on the latter point as the local conditions vary so much from one another. The methods in vogue for the preservation of cattle-dung under Indian conditions have not yet reached such a satisfactory stage that recommendations can be made as to this either, but further local investigations are urged and it is recommended that the biological aspect of the problem should receive attention. It was clear, from the discussion, that the methods of dealing with cattle-manure in the stalls vary considerably, the climatic conditions being among the chief controlling factors. In the drier parts, earth on the floor of the cattle stalls appears to be a useful and efficient method, and in Berar some success has already been obtained through the agency of the agricultural associations by popularising this practice. In other parts such as Kanara, where intensive cultivation is practised, the "box" system is in vogue among the ryots.

Subject VI.—No satisfactory answer could be found to this query, for after a lengthy discussion the Board were unable to accept the Committee's report. It is clearly recognised on all sides that the establishment of a successful oil-pressing industry in India, with a consumption of the oils within the country, must lead to a cheap cake coming into the market. It is the retention of this cake in India, both as a cattle food and as a manure, that is so desirable from an agricultural point of view, but at the present time the economic conditions

prevailing in India and in Europe are such that her superiority in oil-crushing methods and in agricultural practice enables Europe to command the market. The general improvement of Indian agricultural methods and the popularisation of oil-cakes as cattle foods and as manures, offer the best solution to the problem : but will require time to effect.

Subject VII.—In connection with this subject it was felt that the time had now come for the department to give publicity to its work in all its branches. The discussion which takes place at the Board of Agriculture forms an important feature since it brings into focus the immediate activities of the department of agriculture. After some discussion the Board decided that the most suitable method was for a résumé of each day's proceedings to be made by one of the members and sent with the Inspector-General's approval to the principal Indian papers : and this was carried into effect during this Conference.

Subject VIII.—The Board were not in agreement with the proposition to grant honorary diplomas of Licentiate in Agriculture. It was felt that this diploma indicated a new standard of education and that its holder had successfully passed through a systematic course of instruction in technical science. No parallel exists between a University degree and a technical diploma.

Subject IX.—The question of the value of these local bodies as a means of extending agricultural improvement, and the lines on which they can be best organised, has been before the Board on several previous occasions and reports have been issued in 1909 and 1910.

The results obtained from organisation in this direction have been widely diverse in different parts of India. Success in one province has to be balanced by failure in another. There seems little doubt that local conditions and particularly the dissimilarity in the different races and peoples has an important bearing on the results. The lines on which organisation has been carried out also differ, and it is recognised that the type of organisation which exists in one district or province

may be unsuitable for another. In some cases these associations are controlled by the civil district officers and in others they are more or less independent. Notwithstanding the differences of opinion and diversity of results, the Board considered that, broadly speaking, such associations were of value as a means of fostering the co-operative spirit among the people and in spreading information, provided they were established under given conditions. These conditions are that—

(i) They should never be started unless there is some definite work for the members to carry out.—It has not been unknown that associations have failed on account of the want of a feeling of individual responsiblity by the members.

(*ii*) They must be comprised of men who are really interested in agricultural improvement in the district in which they meet.—It is of little or no use to form an association whose functions are chiefly social. If there is definite work in agricultural improvement in the district to be done, the men most likely to carry this into effect are the men to form into an association.

(*iii*) The work must not be allowed to fail from lack of interest by either the civil authorities or the Agricultural Department. The latter should be in the closest touch and regular meetings should be arranged for, in which officers of the department are present. The local associations must be made to feel that the Agricultural Department is directly interested in their success.

Where associations have been formed on lines other than those here laid down, and have been found to be useless, official support should be withdrawn from them and a fresh start made.

Subject X.—The Committee's opinion of the lines on which scientific research in the provinces should be developed was placed on record. A resolution was passed by the Board to the effect that research was to be encouraged and the work of individuals engaged upon it should be as free and unfettered as possible. It was also considered that in view of its importance it will ultimately be necessary considerably to augment the

staff engaged upon it, but beyond this it was unable strictly to define in advance the lines on which its organisation should be developed. It is of interest to note that the Committee in their report recommend that the senior staff in Provincial Agricultural Departments should meet at regular intervals to discuss departmental work, particularly with reference to new lines of work and bringing such results as are of practical utility into effect in the province.

Subject XI.—The chief aim in view in the improvement of crops in India, is the replacement, wherever possible, of the existing mixtures by pure types, characterised by increased yield and improved quality. As regards obtaining better varieties, the Board emphasised the necessity for all work in this direction being based on a close botanical study of the methods of pollination. This is especially necessary in the case of plants which cross-fertilise. It is, moreover, desirable that these preliminary investigations should be local, as several cases were quoted in which the climate had considerably modified the mechanism of pollination. It was mentioned, *e.g.*, that wheats in the Punjab irrigated tracts crossed to a far greater extent than was the case in moister regions. In introducing new varieties of crops the immediate distribution of the imported seed was considered undesirable. Neglect of precautions in this respect probably accounts for the want of success in introducing exotic cottons into India. Work should first be directed to the production of stable agricultural types, which should alone form the basis for future seed distribution. As regards the maintenance of pure types, the Board laid stress on the necessity of the Economic Botanist in each province maintaining a collection of the improved types in process of introduction, to serve as a source from which pure seed could be obtained whenever necessary, to restock the seed farms of the department. In considering the distribution to cultivators, it was recommended that as far as possible the efforts of the department should be directed towards one or two definite problems at a time. It is desirable to confine it in any one tract to one variety only, and this is particularly

the case with cross-fertilised plants. Distribution on these lines has the further commercial advantage of creating large supplies of single types to attract buyers.

As regards the application of these principles, particular attention was directed to examples of successful seed distribution in the Central Provinces and in Madras. The main principle observed is to establish pure types, on the Government farms and to start the distribution from there, the assistance of influential agriculturists in the district being enlisted. The seed is paid for by the cultivators to whom it is distributed, and the work is conducted only in those tracts where markets already exist for produce. Some difficulty has been felt from time to time, in the introduction of new varieties of crops, in obtaining a suitable market and one which will pay the producer an adequate return for this extra outlay. The Board considered that in giving assistance in this direction, the following points have to be borne in mind :—

(i) That a single consignment in a large market or exchange is unlikely to attract much notice unless special attention is drawn to it.

(ii) that occasional consignments do not fetch the same price as produce of recognised value obtainable at regular seasons, and

(iii) that in the future the marketing must be in the hands of local buyers and agents.

Subject XIII. Cotton Investigation in India.—The basis of discussion by the Board was the note on the present condition of cotton cultivation in India by the Inspector-General. In effecting the extension and improvements of Indian cottons one or two points were particularly emphasised. Seed selection and distribution has already commenced on satisfactory lines, and each province concerned is now engaged in the work. It is recommended that the trials with American and Egyptian cottons should be persevered with, as such cottons give greater promise in the newly-irrigated districts of North-Western India and where cotton cultivation is not seen at its best. The most

suitable type of American cotton to introduce into these provinces is an early-maturing variety, and its successful introduction will depend on proper drainage and adequate irrigation. The introduction of irrigated exotic cottons will result in an increase in both area sown and outturn of cotton, but the increase or decrease of total cotton area is really ruled by the markets of the world. It was the opinion of the Board that improved methods of cotton cultivation and maintenance of the cleanliness of the cotton fields will have a greater effect in increasing the outturn over the vast area under cotton than any other methods yet suggested. The value of improved strains is recognised by the Provincial Departments interested in the cotton industry. But in some cases these by no means give the best staple from a manufacturer's point of view, yet, owing to their hardiness, high yield and high percentage of cotton to seed, they retain the favour of the cultivators who at present find them the most profitable to grow. Until a greater distinction is made between the prices of high and low grade cottons, the hardy short staples will continue to hold their own and to increase. One of the chief obstacles which lies in the way of the improvement of cotton staple in India, is that little or no attention is paid, by the exporters, to the actual merits of the cotton for manufacturing purposes. The exporters in India will buy anything, good, bad or indifferent. On the other hand, buyers for Indian mills do appreciate quality of fibre and are willing to pay for it, but they are few in number and cannot do much towards putting up the quality by their demands. It was, moreover, considered by the Board that the best means of aiding cotton cultivation in India are being pursued by the Agricultural Department.

Subject XII. The Cane-sugar Industry in India.—This subject formed the leading feature of the meeting. It was considered by a large and strong Committee which included, besides officers of the department, Mr. W. H. Moreland, C.I.E., I.C.S., late Director of Agriculture in the United Provinces; and Mr. J. McGlashan of the Cawnpore Sugar Works, both

gentlemen being intimately acquainted with every aspect of th industry in the United Provinces. The Committee sent up lengthy report. In order that the discussion of this repo should be as exhaustive as possible and at the same time well t the point, the Inspector-General set apart one entire day for th purpose. It was on this occasion that the Hon'ble Members fc Revenue and Agriculture and for Commerce and Industry wer present, and it is not too much to say that their presence wa felt by the whole Board to indicate the deep interest displaye by Government in this problem and its treatment by the depar ment. A notable feature of this day's proceedings was th introduction of a new system of treating the day's agend which aided considerably in focussing the discussion on mai points of interest, and added dignity to the proceedings. Th was the formal movement of a series of resolutions on th subject-matter of the Committee's report by selected membe of the Board. The first of these resolutions was moved by M Moreland—to the effect that the Board cordially endorses the pos tion taken by the Inspector-General of Agriculture in India his note to the Government of India that the sugar industr deserves the assistance of Government. In the course of h remarks Mr. Moreland gave an interesting sketch of the rise c the industry in the old North-West Provinces and the Kingdo of Agra and Oudh. Cultivators have for many centuries mad *gur* for local consumption, but refined sugar originally arose i answer to court demands. This was the first refined sugar marke in India, and, in the 17th century, the East India Company use to send to Agra, the capital, for sugar. In the 19th century with the extension of law and order and improvements of trad communications, organisation of markets and specialisation of cu tivation set in and sugarcane began to be localised in the North East and cotton in the South-West. There was no foreign com petition to disturb this market. These conditions practicall formed the industry as it exist at the present day in these part The growers of cane were neither capitalists nor specialists, bu the best cultivators grew plots of cane, entering into co-operatio

rather than paying cash wages. We consequently find the defects common to agriculture existing there,—cultivation good within the limits of the implements and cattle power, but varieties of cane varying greatly in quality and the methods of manufacture crude and wasteful. One of the important features of the industry in these parts is the employment of labour at a time of the year when there is little else to do, the industry thus acting as a labour savings bank in a country of small holdings and consequently adding largely to the financial prosperity of the people. On these grounds alone every effort which can be made to save the industry from extinction by foreign competition is fully justified.

At the end of the last century competition due to sugar bounties was checked by countervailing duties and the Brussels Convention, but was rapidly followed by competition from Java. *Gur* was threatened by the growing change in taste in favour of sugar and by the increasing importation of the latter. Roughly speaking, the area grown for *gur* is not yet affected, but that grown for sugar is. At the present time only the Hindu sentiment in favour of country-refined sugar saves it from extinction. This sentiment is certain to grow weaker as education and civilisation spread, and the present breathing space thus allowed to us should be utilised to its fullest extent to place the industry on a firm footing.

The second resolution passed by the Board dealt with the necessity of appointing a Sugar Engineer. The third resolution dealt with the acceptance of the Committee's recommendation of a programme of agricultural work in connection with the industry. In this the necessity of a preliminary survey under chemical control of the canes existing in the various districts was emphasised. The testing can be carried out for the most part at the agricultural stations situated in the cane-growing tracts. Imported varieties which appeared to be suitable should also be included in the preliminary survey. The work of the department should afterwards follow the lines of spreading the best varieties, so determined, by distribution among the better cultivators; and the demonstration of improved mechanical

methods of *gur* making. A study of methods of tillage, watering, manuring and drainage directed to achieving an increase in the weight of cane per acre, should receive attention at local agricultural stations, and in districts where improved cane cultivation is to be demonstrated. Special stress is laid upon the necessity of locating sugar stations within the sugar tracts and only in such tracts. A definite recommendation was made for the establishment of a sugar station, north of the Ganges, in Bengal.

The fourth resolution was that the Board accepted the Committee's recommendations regarding the establishment of an acclimatisation and cane-breeding station for India, and recommended that it should be in Madras. This was necessary as canes were found not to "arrow" properly in North India, and consequently breeding experiments could not be undertaken there. No difficulty is anticipated by the botanical experts in moving canes to the Madras station from the North for the purpose of breeding, and then sending back the improved progeny for multiplication on agricultural stations lying in the colder zones. It is also considered that such a station will serve as a useful stepping-stone into the country for improved varieties from abroad.

In the fifth resolution the Board recognised that the primary object in cane selection and improvement is the production of better canes with purer juice and giving an increase of tonnage per acre. The realisation of this aspect is particularly important in preparing the way for an Indian refined sugar industry. Some of the chief difficulties in manufacturing methods arise from impurities in the raw material. Methods of boiling can be more easily adjusted. We have every reason to believe that the retarding influence of a cold climate and shorter season results in the decay of the sucrose matrix into undesirable by-products. It is therefore of the utmost importance in attempting to establish a refined cane sugar industry in such comparative rigorous climates as the North-West of India that the constituents of the cane other than sucrose should be studied in detail during the process of selecting the canes.

In the sixth resolution the Board considered that the area under sugarcane in India can be considerably increased by the application of capital and the introduction of more efficient methods of cultivation and manufacture. The recommendation of the Committee, that all possible facilities should be afforded to capitalists, small and large, who are prepared to enter on this industry, was accepted by the Board. Attention was drawn to the large areas of land, suitable for the cultivation of sugarcane, at present lying waste in Eastern Bengal, Assam, Burma and elsewhere. Such land can be roughly classed as (*a*) land available on the margin of cultivation and (*b*) undeveloped land. The profitable utilisation of the first would depend upon reducing the cost of production by intensive cultivation, involving the application of capital, and by the use of modern and less wasteful methods of manufacture of the finished product. All these involve the outlay of capital. As regards the second, the chief difficulties in the way are, roughly speaking, the want of water and labour and the cost of cleaning. The water question is receiving the attention of the Government of Madras, but there and elsewhere capital is required for cleaning the land as well as establishing the factory. In order to attract the capital, the Board considered it advisable that all provincial Agricultural Departments should make it their aim to be in a position to supply the fullest possible information to likely investors and to push the spread of this information as much as possible.

In resolution seven, the Board recognised the value of the action already taken by some Local Governments, in reserving certain areas of suitable land for the establishment of central factories, and expressed the hope that this action might be extended to granting land on favourable terms to manufacturers. In this connection it is of importance to note that the successful establishment of a sugar industry in India depends upon the production of an indigenous article at least equal to, and costing no more than the minimum price fetched by the imported sugar. A factory entirely dependent on purchased canes would be in an

insecure financial position, owing to fluctuation of prices and competition, and consequently capital would be shy. If factories could obtain grants of land, and grow at least a portion of the cane necessary to keep them going, they would not only be in a more secure financial position and give a greater guarantee of success to investors, but they would be able to set a standard of cane cultivation, attract supplies of cane, advance money for cultivation, and generally co-operate with the Agricultural Department in demonstrating methods of cane-growing and in spreading information about it.

In the eighth resolution the Board recommended that Local Governments should be empowered to assist pioneer factories, by subsidy, by taking deferred shares, or by such other methods as might appear appropriate. The Board were of opinion that such assistance is essential in the earlier days of the industry, and until there is a steady flow of capital towards it,—capital which can only be attracted in a country like India by patent success. India, too, differs from other countries in that it is difficult to obtain possession of land by lease or purchase. The Zemindari and Rayati system of dual ownership causes a difficulty in obtaining sole rights. In order, therefore, to avoid the heavy outlay for acquisition, combination between the two parties is necessary, and this doubles the risk as compared with cases where single control can be obtained and results rapidly judged.

In the Committee's report on the area of land available in different parts of India for the extension of sugarcane cultivation, some interesting facts and suggestions were forthcoming from the United Provinces. It is this province which is likely to be most seriously affected by the decay of the Indian sugar industry, as it is also the province which has suffered by the curtailment of the poppy crop. The normal area under cane in these provinces may be taken in round figures as 1·2 million acres. After a succession of good years the crop has increased by as much as ¼ million acres, and after bad seasons has fallen as much as ½ million acres. In Mr. Moreland's opinion the area under cane, there, is governed by probable prices, and by the

economic condition of the cultivating classes for the time being. It is noticeable that the area of cultivation which has fallen off is in the districts producing refined sugar. All these districts may be considered as lying in sugar tracts, and a resuscitation of the Indian sugar industry would be followed by these areas again coming under cane-cultivation. With reference to the further extension of the area under cane, it was pointed out that in addition to the half million acres now short of the maximum, a further 300,000 acres out of the 400,000 acres of poppy land might be considered available for cane-cultivation, provided cane-growing could be made somewhat more remunerative. In all, it was considered that in these provinces alone, within five years, it would be possible to increase the area under cane by a million acres without seriously affecting existing agricultural economics

CLIMATE AS A FACTOR IN THE RICHNESS OF SUGARCANE-JUICE.

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The question of the possibility of increasing the sugar content of sugarcane juice is one that has occupied chemists, botanists, and agriculturists for the last century. The sugarcane is easily grown, over an enormous range of country with very varying climates, ranging from temperate to equatorial. In spite of these enormous differences in climate, however, the actual canes, when acclimatised, show on the whole a singular constancy in the composition and general properties of their juice. In this way we find that cane-juice can, sometimes, be obtained in the subtropical parts of Bengal, of as great purity and richness as in the equatorial islands, in which the sugarcane flourishes with the greatest luxuriance. Whether it can always be obtained, or even that it is generally obtained of such a richness, is doubtful, for reasons which will appear later.

Although, as has been said, the general characteristics of cane-juice are similar throughout the world, yet many factors influence the variation of the general purity and saccharine richness of any particular cane in any one place. Foremost among the factors influencing the value of any particular cane comes the climate of the place in which it is grown, and it is probable that, although most varieties of cane will come to perfection when grown in tropical climates, yet that the great changes taking place in subtropical climates demand a special type of cane. In such regions as these, in which the fluctuations of temperature and rainfall are enormous, not only from season

to season, but from year to year, the problem of cane-selection must largely resolve itself into that of the production of a hardy cane, that will undergo such fluctuations without harm, and that will produce the maximum amount of sugar during the one short period of the year that is favourable to the manufacture of the crop, and, if possible, by judicious selection of these hardy varieties, to lengthen the cropping period. This period is in such countries very much more restricted than in lands of more equable climate. In Louisiana, in fact, as will be shown later, it is ended by such cold weather that the death of the cane and great loss of sugar is caused by delaying the harvest till during the winter. Since this is the case, one of the most important factors determining the value of a cane for sub-tropical climates is its period of maturity. It will, then, be of great interest to discuss the changes of richness of the juice of canes from their unripe state to that of perfect maturity.

The number of varieties of cane is very large, and is yearly increasing by the introduction of new seedlings bred in climates suitable for the purpose. Even excluding these new seedlings, there are innumerable different races, each having different properties, and probably suitable to the different types of soil and climate in which they are grown. That everyone of these canes gradually stores up more sugar from its youth to maturity is obvious. The rate at which this storing up takes place, however, has a great bearing upon the value of a cane for any particular climate, particularly in those climates outside the tropics which are subject to extreme changes in temperature. As a case in point, an example may be taken from different results obtained in Louisiana, which is subject to a very hot summer and a very cold winter. The effect of the cold upon canes has been illustrated by Stubbs (Bulletin 37, Louisiana Experiment Station), in which he shows deterioration due to frost in analyses made at the beginning of the cold period at the end of December. In these results he shows that the sucrose content decreased from 11·85 % in the juice at the beginning of the frost on December 27th, to 8·66 % on the 15th January. He expresses the view that

the frost killed the cane cells, causing an intermixture of the different kinds of sap, which then decomposed. In this way it is evident that a cane which nears maturity early, is of far greater use in Louisiana, than one which matures late, so that a maximum amount of sugar can be obtained before the cold weather sets in. The problem, then, of obtaining canes suitable for the Louisiana climate resolved itself into an attempt to obtain heavy yielding canes of early maturity, so that they may give juice of fair richness and purity before the frost sets in to kill the canes. In order to obtain new varieties, trials were first made to secure seedling canes by growing the canes under glass. These trials were unsuccessful, and, since 1893, the work of getting better strains of cane for Louisiana has consisted in the importation of different varieties from other cane-growing countries. As a result of this, D74 and D95 were imported from Demerara, and, according to a paper published in the *Louisiana Sugar Planter* of this year, these canes have shown a marked superiority in tonnage and sugar content over the older Louisiana canes in nearly every part of the Louisiana sugar belt. This is all the more interesting as, up to that time, the Purple and Striped canes had held their own against all-comers for seventy-five years. It is also interesting to note, from the above-mentioned paper, that D74 and D95 are the only foreign seedlings that can be recommended in an unqualified manner, even though many have been introduced that have given notable results in other countries, and it is expressly stated that the reason for this is to be found in the fact that D74 and D95 are early maturers, and that, in a locality where the growing season is of short duration, they are particularly desirable.

The period of maturity of a cane, then, has been recognised in Louisiana as one of the most important factors determining its value, in that early-maturing canes give juice of a fair richness and purity before the cold weather sets in, while canes of longer growing period are so checked by the coming of the winter that they become valueless in a short time. In connec-

tion with this it may be assumed that all climatic conditions are much more likely to affect a cane when unmature than when mature, and it is, perhaps, owing partly to this that the hoped for success has not been achieved with the large canes recently introduced into Bihar. It would appear from figures published by Geerligs and also in the *Louisiana Sugar Planter* in April last, that the Louisiana cane-juice is, as a rule, of far lower sugar content than that of most other sugar countries. For instance, 11·5% is mentioned by Mr. Hamilton Agee in the *Louisiana Planter* as being the average of the D74, and many other figures are given for other canes which are lower than this. In striking contrast to this we have the examples of such tropical countries as the various West Indian islands, in which 20% in the juice is by no means an uncommon richness, while certain abnormal canes have been known to give juice of 22% richness.

In tropical islands this period of maturity is perhaps not so important as in less equable climates. For instance, analyses published by Geerligs* show that the following changes were found in Java :—

Date of Analysis	Sucrose in Juice.	Purity.
27th March ...	17·81	91·9
10th April ...	18·34	93·1
20th ,, ...	18·77	93·3
30th ,, ...	18·75	93·2

Such a table as this shows that, under the climatic conditions of Java, the cane was allowed to attain its maturity, and that while mature there was very little change for the whole month of April.

In the case, however, of a country having a marked cold season such as Louisiana the conditions are quite different. On studying a table published by Brown and Blouin for 1903 and shown in Geerligs' book on "Cane-Sugar and its Production" one is at once struck by the great jumps from one month to the

* Cane-sugar and its manufacture.

next, both in sugar content and purity. The table is given slightly altered in order to compare it with the table above.

Date of Analysis.		Sucrose	Purity.
1st August	...	2·70	36·00
1st September	...	5·97	57·02
1st October	...	11·27	76·72
1st November	...	13·69	87·85
15th "	...	15·86	92·10

No statement is made in the above-mentioned book as to whether the cane was cut at the stage reached on November 15th, but as no further analyses are given, it is assumed that this was the case. Apparently the cane had just approached its maturity on November 15th and may be considered to have been in the same condition as the canes analysed in Java on the 27th March and given in the table above. These two tables illustrate admirably the advantages of such a climate as that of Java, over that of Louisiana, in that the former will bring canes right up to maturity, after which there is little change during a whole month, while the Louisiana canes must apparently, to avoid loss by frost, be cut just before they have had a chance to ripen thoroughly: unless an early maturing cane be chosen. The enormous jumps in the sugar content of the juice while immature render it essential that the cane shall be cut somewhere near maturity, when the changes are slow; and the intensity of the cold weather in such a climate as Louisiana, or any other country subject to hard frosts in the winter, demands that the cane shall be cut before the cold weather sets in, unless it is hard enough to resist the killing effect of the frost. In this way the introduction of early-maturing varieties appears to have been of great help to the Louisiana sugar-industry.

As is to be expected, many of the so-called varieties of cane found in Bengal show differences in periods of maturity; and the analyses show, also, how necessary it is to attain maturity if possible before cutting the cane, but that when maturity is attained, the changes are small enough to be negligible for practical purposes. Taking three striking examples of analyses o

canes made in 1910 and tabulating some of these analyses, a comparison may be made with the Java and Louisiana results :—

	Khari Cane.		Shakar-Chynia.		Hemja.	
	Sucrose per cent.	Purity.	Sucrose per cent.	Purity.	Sucrose per cent.	Purity.
Mid January ...	15·78	92	16·70	87	13·51	83
End ,, ...	15·95	85	16·92	89	16·23	90
Mid February ...	15·64	83	17·18	85	16·23	85
Early March ...	15·65	82	16·95	89	18·02	91

It will be seen from this that Khari cane had attained its maximum maturity by the middle of January, and Shakar-chynia had practically done so ; while the sucrose richness of the juice of the two canes remained fairly constant over a period of a month and a half. This is of great interest, as such constancy in composition over such a long time is, of course, of great value to the cultivator as lengthening the time over which he may work with profit. On the other hand, the juice of the cane known as Hemja changed during the same period from a saccharine richness of 13·5 to a saccharine richness of 18. In other words, its saccharine richness increased by over 30 per cent. between January and March, while the Khari and Shakar-chynia canes hardly increased or diminished. Such a difference as was found in the case of the Hemja variety is, of course, sufficiently marked to be noticed even in *gur* manufacture, in which changes in juice-composition are generally masked by the wasteful methods used in manufacture. In the case of sugar manufacture the state of the juice is, of course, of the highest importance, while even in *gur* manufacture the very immature cane frequently used by the raiyat produces an exceedingly inferior article.

Taking into consideration these differences in maturity, it is possible to imagine the lengthening of the reaping season by actual selective cutting of varieties by quite a month, as experiments made this year show very little loss by reaping Khari and Shakar-chynia varieties in early December, while dwarf canes attain their maximum about March. The following results

obtained this year from analyses every 10 days, will illustrate this point as being taken from an earlier date than last year's results :—

	Khari.		Buxaria Dwarf Cane.	
	Sucrose per cent.	Purity.	Sucrose per cent.	Purity.
Early December	13·60	85·3	10·62	83·8
Mid ,, ...	13·67	88·9	12·84	84·3
Early January	14·14	84·6	12·70	84·5
Mid ,, ...	14·16	84·3	13·59	89·0
Late ,, ...	14·72	87·6	13·21	85·0
Early February	15·05	87·4	13·75	81·9
,, March	...	..	16·39	89·8

The extraction results are not shown here, but they further point to the fact that Khari ripened early and Buxaria late ; for the maximum expression was obtained from Buxaria on the 1st March, while expression in the case of Khari showed a tendency to decrease after January 14th. It will be seen that the quotients of purity obtained were not so constant in their rate of change as the actual sucrose determinations. This is probably partially due to the fact that the samples were sterilised with corrosive sublimate, which was only measured approximately and which may have affected the quotient of purity. The measurements involved in the determination of quotients of purity as compared with those of actual sugar content are, however, of necessity likely to give inaccurate results in the extreme variations of temperature experienced during the Indian cropping season.

It will be seen, then, that the differences in periods of maturity of the canes have a great bearing upon the value of a cane planted, in climates which are extra-tropical and subjected to violent changes of temperature. In such climates, as has already been pointed out, a cane is required which either comes to maturity early, that is to say, in the warm moist season preceding the cold weather, or is sufficiently hardy to withstand the bad effects of cold weather. It is possible that the non success of many of the large thick canes recently introduced into

Bihar has been largely due to the fact that such canes require from at least a year to 18 months for their growth, and that they are unable to resist the strain put upon them by the rigours of a Bihar winter while they are still immature.

Some experiments were carried out at Burdwan this year to compare the Khari cane, which is known to be an early ripener, with some of the large Java cane imported there some years ago and said to be singularly good in point of yield and disease-resisting power. This was particularly interesting from the point of view of the fact that the Java canes are of a new type in Bengal and have not been in any way sorted out by time and practice into any particular group of early-ripening and late-ripening canes. It has been noted in this Journal * that the observation of the maturing period of canes is of great importance in the determination of their value, and sufficient has been said to point out that this fact is realised in other parts of the world, and that the work is well worth following up in any country in which a systematic attempt is being made to classify and determine the value of sugarcanes. It will be, then, of interest to show the results obtained with these Java canes grown at Burdwan in comparison with the local cane known as Khari. The whole field was sampled and the sample was reduced by the ordinary method of laying out the canes, at random, in a row, and taking every 10th cane. The canes were then crushed and carried in bottles 'dosed' with corrosive sublimate to Sabour where they were analysed on the day following that of crushing.

The results obtained were as follows :—

Date.	Saccharose per cent.		Glucose per cent.		Quotient of purity	
	Khari cane.	Java cane.	Khari.	Java.	Khari.	Java.
December 10th ...	12·87	12·94	1·1	2·0	81·8	76·7
January 2nd ...	15·45	13·27	1·0	2·0	90·1	80·5
,, 12th ...	15·39	14·13	1·2	1·8	84·2	78·3
,, 22nd ...	15·37	13·88	1·2	1·8	85·2	79·5
February 1st ...	15·71	13·37	1·1	1·6	88·7	82·5

* Barber. Vol. I. Part III, page 129.

It will be noted that here, as in the other results of this year, the quotients of purity show marked fluctuations. This is, as before, probably partially owing to the fact that the sample bottles were in every case dosed with corrosive sublimate in rather large quantities to prevent fermentation, and that these quantities were not carefully weighed. As a consequence, the specific gravities from which the quotient of purity is calculated, and in consequence the quotient of purity itself, cannot be regarded as anything but an approximation to the truth. On the other hand, the saccharose and glucose determinations may be regarded as exact, the more so as the juice had been sterilised by corrosive sublimate immediately after crushing.

These results show us one or two interesting facts about the Khari and Java canes grown at Burdwan this year. Firstly, regarding the sucrose content we find that the two canes started almost dead level at the beginning of December, but that the Khari cane-juice showed a large jump to over 15 per cent. sucrose by January 2nd, which strength it maintained until February. It has already been pointed out that a similar characteristic has been found in the same type of cane at Sabour for two consecutive years. On the other hand, the Java cane rose slowly in sucrose content until January 12th, and then began as slowly to decrease. At no time was the juice of the Java cane as rich in sucrose as the Khari cane, while on the other hand, the glucose content of the Java, although it showed a tendency to decrease, never got so low as in the case of the Khari cane. It would appear, then, from the figures, that the Java cane began to mature later than the Khari cane, and that the cold weather of Burdwan in January had such an effect upon the cane, which was of rather a delicate type, that it refused to attain a reasonable percentage of sugar or to maintain even the low maximum to which it reached, while the more hardy Khari was able to maintain a reasonable sucrose content for a whole month.

It has long been known that the thick canes so profitable in the tropics have been found very difficult to grow to advantage in sub-tropical climates, and it would appear that the figures cited

above throw some light upon the reason. It is then, somewhat, difficult to say whether one variety is richer in sugar than another, until experiments have been made on each one at its actual period of maximum maturity; and observers may easily be led astray if they compare the varieties at any other time. As a case in point may be taken the two varieties, Khari and Hemja, which, according to the results obtained at Sabour in 1910, would have shown that Khari was far the sweetest in January, while in March the reverse would have been shown.

It will then be seen that, in the determination of the value of a cane for a sub-tropical climate, the period of maturity of the cane is a factor of the utmost importance. The sub-tropical climates, with their demand for early-ripening canes and their ripening season of only ten months to a year, necessarily produce different changes in the cane than the equable tropical-island climates in which cane can grow continuously for 15 months or even two years. It will also be found, on reference to results obtained all over the world, that the annual variations of sub-tropical climates produce far greater yearly changes in the composition of the juice of their cane crop than the more equable tropics, in which also the rainfall is subject to fewer fluctuations. This is shown very strikingly in some results shown for Louisiana by Browne and Blouin in 1903 and 1904, and cited by Geerligs (Cane-Sugar and its Manufacture, p. 77). These workers showed that a deficiency of rainfall after August, which appears to be the season at which ripening sets in rapidly over Louisiana, produced, in 1903, a ripening to an extent rarely experienced in Louisiana, while causing a decreased growth in the cane. On the other hand, in 1904, when the rainfall was sufficient and the season favoured the growth of the cane, the juice-richness was not nearly so great. This, as has been said above, is probably due to the fact that the canes were allowed to grow right on into the cold weather, after which they could not mature. Similar fluctuations have been observed in canes grown in Bengal. For instance, the Khari cane, after the long drought of 1908, gave, in the season 1908-9, very stunted cane, but a juice having about 19 per cent.

sugar,' on the average. In 1909-10 the conditions were more favourable to its growth and a much heavier yield of cane was obtained, while the maximum attained was only 16 per cent. in the juice. In the cutting season of 1910-11, after a year of exceptionally favourable rainfall, producing a very heavy yield of cane, the maximum attained by this cane was only 15 per cent. of sugar in the juice, though the total yield of sugar per acre was far greater than it was in the previous year. In sub-tropical climates then, the cane has to compete, not only with the rainfall, but also with the temperature; while in the tropical countries the only fluctuation is caused by the differences in rainfall, and is, as a matter of fact, very slight from year to year. The greatest fluctuation observed by Kobus in twelve years, in Java, was from 9·57 per cent. sugar extracted from 100 canes (about 12·5 per cent. juice-richness) to 10·94 per cent. (about 14 per cent. juice-richness), while in Louisiana there was a fluctuation of nearly 4 per cent. in juice-richness between one season's observations and another, and in Behar similar changes have been observed.

In choosing suitable canes, then, for countries outside the tropics, the difficulty of the choice is enhanced by the demand that the canes shall not only be hardy, to resist the attacks of animal pests and disease, but that they shall also come to a maximum sugar content under conditions varying, from year to year, within a very narrow period, the length of which varies very little.

PAUNDA SUGARCANE CULTIVATION AROUND PESHAWAR.

By W. ROBERTSON BROWN,

Superintendent of Farms, North-West Frontier Province

In 1853-54, during one of his short respites from hill fighting, Captain Coke, the Deputy Commissioner of Kohat, introduced a hard-skinned red "*paunda*" cane to his district. This variety continued to be cultivated until about 1867-68, when it was discarded in favour of a softer white "*paunda*" cane from Hindustan. The new variety rapidly gained in favour and entirely supplanted the kind first imported. It soon found its way to Peshawar, and in 1910 it was the only variety cultivated for *gur* or for chewing-cane, in the district. In 1900 the area under sugarcane in Peshawar was 15,338 acres, and in 1910 this had increased to the substantial total of 25,609 acres.

Climate of Peshawar.—The following is the description of the climate of Peshawar given in the Gazetteer dated 1897-98. Four seasons are recognised in the Peshawar Valley. Spring (*sparlai*) in February, March and April. During this season there are occasional hail-storms, and rain falls in the first two months to the extent of three or four inches in the aggregate. The air is cold and bracing, and the temperature is as follows :—

Spring.	Sun's Rays.		Open Air.		Daily Range.	
	Max.	Min.	Max.	Min.	Max.	Min.
February	116	75	68	17	44	22
March	130	92	82	29	38	21
April	145	127	98	31	92	40

Summer (*orai*) in May, June and July. During this season the air is densely hazy; dust-storms are of almost daily occurrence during the last half of the period. During the first half of this season strong northerly and north-westerly winds blow. Thunder-storms are of common occurrence upon the bordering hills, and often the dust-storms are followed by considerable electric disturbance, but rain rarely falls on the plain. This is the hottest season of the year and usually the most healthy in the valley. The temperature is as follows :—

Summer.	Sun's Rays.		Open Air.		Daily Range.	
	Max.	Min.	Max.	Min.	Max.	Min.
May	165	121	139	35	88	56
June	165	153	139	38	77	59
July	165	152	137	58	72	49

Autumn (*manai*) in August, September and October. This season is ushered in by the hot-weather rains (*barshakal*). They break over the valley in four or five violent storms at intervals of a few days, and two or three inches of rain fall on each occasion. During the first half of this season the sky is more or less uniformly overcast with clouds, and the air is heavy and stagnant, except for a brief interval immediately succeeding a fall of rain, after which it becomes steamy and oppressive. This is usually a very unhealthy season, particularly during its last half, in which marsh fevers are rife. The temperature is as follows :—

Autumn.	Sun's Rays.		Open Air.		Daily Range.	
	Max.	Min.	Max.	Min.	Max.	Min.
August	161	140	129	50	72	56
September	152	140	123	40	78	56
October	140	129	102	30	70	57

Winter (*zhima*) in November, December and January. During this season the weather is variable. The sky is at first

hazy ; then cloudy with, sometimes, slight rain ; and finally clear. There is a remarkable absence of wind generally, and at Peshawar especially the air is still and stagnant. The days are sometimes hot and the nights always cold. In all this season marsh fevers and inflammatory affections of the lungs and bowels are very prevalent. The temperature is as follows : —

Winter.	Sun's Rays.		Open Air.		Daily Range.	
	Max.	Min.	Max.	Min.	Max.	Min.
November	132	112	96	25	64	20
December	112	69	85	24	33	19
January	119	88	65	22	43	19

Soil and Irrigation.—The Charsadda *tahsil*, with wide tracts of rich alluvium and an abundant supply of water from the Kabul River Canal, produces the heaviest crops of cane with perhaps the least labour. In the vicinity of Peshawar the deep, red, sandy loam is usually enabled to yield good outturns by the constancy of the canal supply.

Preparation of the land.—*Shaftal* (*Trifolium resupinatum*) is the great enricher of the irrigated land in the valleys of the North-West Frontier Province, and it enters into most of the rotations which include sugarcane. It is sown in September, in growing maize. In early April, whilst this fodder is still green and vigorous, shallow furrows are cut by the country plough 3 feet asunder, in the crop, and the cane is planted ; or sugarcane may follow maize, without *shaftal* intervening, in which case the land is very frequently ploughed between mid-December and the date of cane-planting. Not infrequently sugarcane is planted, in growing wheat, in late March, but this rotation is usually the result of special circumstances, and is avoided as far as possible, as it is recognised that manuring must then be exceedingly generous. Planting in growing *shaftal* is the most common practice, and it has been found that cane after *shaftal* almost entirely escapes the attacks of the borer which does much

injury to cane after maize and winter fallow. It is probable that the larvæ of the borer are killed during winter by the very heavy irrigation which *shaftal* receives. Most zamindars acknowledge that better crops of cane are produced after winter fallow and frequent ploughing, if the cane escapes the borer, but cane after *shaftal* is maintained to be the most reliable and profitable husbandry.

Planting.—In late March or early April planting begins. The store pit in which the full length cane has been kept since November, secure from frost and vermin, is opened, and the cane is rapidly chopped into lengths of about 14 inches. A few men carry the sets to the field to be planted; others distribute the cane along the furrows, and the planters follow, placing the sets straight, eyes upward, and applying a handful of soil to each of the ends of the cane. The sets are not covered with soil. The men who prepare the sets for planting observe that the eyes are sound, and discard any pieces which are badly affected by "red rot." The root ends of the canes are specially liked for planting. Liberal irrigation is given to the growing *shaftal* in which the sugarcane is planted, and the dense carpet of cool luxuriant *shaftal* keeps the soil sweet, and maintains a humid cellow atmosphere which rapidly pushes the sets into vigorous growth. The final cutting of *shaftal* is taken about 15th to 20th May, when the uprising cane shoots are about 18 inches or 2 feet in height.

Cultivation, Weeding and Manuring.—In the Pathan's method of cane cultivation, interculture, weeding, and manuring are parts of one job. Whilst the land is still moist after the last cutting of *shaftal* has been taken, hoeing with *khurpas* and weeding are done. Weeds are removed from the lines of the cane and a handful of mellow manure is applied directly around each plant. The second stirring of the soil and weeding is also done by the *khurpa* usually about 6 weeks after the first stirring. On this occasion manure is more liberally doled out. In the third turn of cultivation the soil of the interlines is slightly dug over, two men jointly pulling and inverting each spadeful. A

the manure the cultivator can afford is piled around the plants on this occasion. Decayed farmyard manure, so mellow that it can hardly be distinguished from rich brown friable loam, is practically the only fertilizer used in the North-West Frontier Province. It is highly valued everywhere, and, as applied, is undeniably excellent in its effects. The disputed ownership of village manure heaps causes many feuds and much litigation. Manure is so valuable that it is rarely or never ploughed into the land. For every crop it is conveyed to the field on bullocks, and doled in sparing handfuls to the plants. The crumbling soil from the mud walls of many villages has fertilizing properties, and a few industrious zamindars collect and apply this to sugarcane and maize, but the practice is not general.

Labour.—In a district where the soil is generally rich and cultivation fairly intensive, and where the greater part of the land is cultivated by small holders, labour is scarce and dear. There the Pathan is stalwart and feeds well. He is fairly independent, and, at present, is unwilling to work for less than annas 8 per day of 8 hours. During the busy season it is customary for the larger zamindars who employ labour, to pay annas 7 or annas 8 per day of 6 hours, and they frequently feed the men besides.

Earthing up.—The piling and packing of soil around the massive stools of cane is done in late August and is the final operation in the actual cultivation of North-West Frontier Province cane. Though storms are frequent, the Peshawar grower trusts to earthing up for the upholding of his crop. Plate No. II shows a group of Pathan labourers who have just finished their six hours' day at this sweltering work.

Diseases and Insect Pests.—Red rot, black smut and several diseases which injure the leaves, affect the cane. The first mentioned is far the most destructive: it causes considerable loss in every plantation, yet no effort is made to check its havoc. A very *red* set is discarded; a slightly affected part is hopefully planted. Owing to the practice of planting in growing *shaftal*, white-ants and the moth-borer

PLATE II

PATHAN LABOURERS AFTER THE DAY'S WORK.

are rarely very serious pests. The grasshopper is perhaps more commonly destructive. Jackals happily do not abound.

Cost of the cultivation of 1 *acre of Paunda Cane.*—In the following table, calculations are made on a basis of hired labour at annas 8 per man per day, with manure at 3 buffalo loads, of 4 maunds each, per rupee. Ordinarily, the cane-fields are about 1 acre in extent, and much of the work of the plantation is done by the zamindar, his family, and the neighbours, who join in helping one another.

Paunda Sugarcane planted in growing shaftal.

		R.	a.	p.
Furrowing for sets	1 pair bullocks and man, 2 hours	0	4	0
Cost of seed cane	45 maunds @ 2 mds. per rupee	22	8	0
Planting—				
(1) Opening store pit and cutting cane	2 men, 1 day	1	0	0
(2) Conveying sets average distance to field	2 buffaloes and 4 men, 1 day	3	0	0
(3) Distributing sets in field	2 men, 1 day	1	0	0
(4) Planting sets	2 men, 1 day	1	0	0
(5) Preparing channels, etc.	2 men, 1 day	1	0	0
(6) Cutting *shaftal**	8 men, 1 day	4	8	0
1*st Hoeing, Weeding and Manuring*—				
(1) Hoeing and Weeding with *khurpas*	20 men, 1 day	10	0	0
(2) Cost of manure	11 buffalo loads	13	5	4
(3) Conveyance of manure to field	3 buffaloes and 4 men	3	8	0
(4) Applying manure to plants	10 men, 1 day	5	0	0
2*nd Hoeing, Weeding and Manuring*				
(1) Hoeing and weeding with *khurpas*	20 men, 1 day	10	0	0
(2) Cost of manure	50 buffalo loads	16	10	8
(3) Conveyance of manure	4 buffaloes and 6 men	4	8	0
(4) Applying manure to plants	12 men, 1 day	6	0	0
3*rd Hoeing, Weeding and Manuring*—				
(1) Hoeing with spades	14 men, 1 day	7	0	0
(2) Weeding lines	8 men, 1 day	4	0	0
(3) Cost of manure†	50 loads	16	10	8
(4) Conveyance of manure	4 buffaloes and 6 men, 1 day	4	8	0
(5) Applying manure	12 men, 1 day	6	0	0
Digging interlines preparatory to final earthing up	12 men, 1 day	6	0	0
Earthing up	12 men, 1 day	6	0	0
Irrigation 30 to 36 times	36 men, ½ day	9	0	0
Revenue		5	8	0
Rent of land		15	0	0
Contingent expenses.				
Collecting shoots affected by borer, tying up falling cane, etc., etc.		5	0	0
		187	14	8

* Shaftal is sometimes sold and is then cut by the purchaser.

† Manure is not always applied on this occasion.

Outturn.—In a future article actuals in weight of cane, yield of *gur*, etc., will be given. Reliable data are not at present available, but the most capable and experienced sugarcane-growers say that 80 maunds per acre of good quality *gur* may be

expected, under the cultivation described in the foregoing pages. Sixty maunds per acre is a fair average crop. Around Peshawar city the sum of Rs. 300 to 500 is frequently realized from one acre of chewing-cane. On 1st September last the price of first quality *gur*, in Peshawar market, was Rs. 11 per maund. In January of the same year the price was Rs. 6.

A SUGGESTED IMPROVEMENT IN SUGARCANE CULTIVATION IN THE INDO-GANGETIC PLAIN.

By ALBERT HOWARD, M.A., A.R.C.S., F.L.S.,

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"India is importing more than half a million tons of sugar annually."

THE increasing import of Java sugar into India indicates clearly that this material can be produced more cheaply than in this country. Any practical method therefore which will either cheapen the cost of production or increase the yield of cane per acre in India should receive attention at the present time. It is suggested that in some sugar tracts, in the Indo-Gangetic plain at any rate, it will be found possible both to cheapen the cost of production and also to increase the tonnage of cane per acre by modifying the present methods of preparing the land for this crop.

One of the most striking features of cane cultivation in India is the large sum represented in the application to the land of oil-cakes and other organic manures such as cattle-manure. This is particularly noticeable to anyone coming to India with West Indian experience of this crop. In the West Indies, soluble artificial manures like sulphate of ammonia are largely imported for the cane, while bulky organic manures are of less account. A little consideration of the working conditions of these two regions furnishes an adequate explanation for such very different manurial practices. In tracts like British Guiana the rainfall is large and well distributed. This combined with a clayey soil removes moisture as a limiting factor in cane-production. Under such circumstances soluble manures like sulphate of ammonia produce well-marked results,

and give rise to greatly enhanced crops. In India, on the other hand, the rainfall in most sugar-growing localities is not well distributed. The cane has often to be grown in tracts in which long periods of drought are combined with high temperatures, clear skies, and drying winds. The rainfall has to be supplemented by irrigation to enable the crop to survive at all. Further, in the driest sugar tracts like the United Provinces, the narrow-leaved, drought-resisting canes only can be profitably grown, and the broad-leaved canes of the tropics, which require more moisture, are not seen in the fields except near cities on highly manured and constantly irrigated land, where they are grown for chewing purposes. These facts clearly point to moisture being a limiting factor in cane-cultivation in India. Regarded from this standpoint, it is not surprising therefore that experience has taught the cultivator that organic manures, which increase the moisture-retaining power of the soil in addition to supplying the necessary nitrogen, are the best for the sugarcane crop. Indeed, it may be possible that in some localities such as the Bombay Deccan,* where it is stated that the most economical quantity of nitrogen to be applied is between 350 to 400 lbs. per acre, a good deal of money is being wasted in applying too much manure. The sugarcane does not require so large a quantity of nitrogen, but it is possible that the application of the bulk of organic manure which contains this amount of nitrogen may be necessary for retaining moisture. Perhaps, the ryots of the tract round the Manjri farm are, so to speak, burning their houses to roast their pigs. Possibly a much smaller amount of manure might give the same result if supplemented by some cheaper form of moisture-retaining organic matter.

It is suggested that, wherever possible, the cultivation of *sann*, as a green manure, before sugarcane, should be made the subject of exhaustive experiment, especially in Bihar and in the United Provinces. This crop could be sown at the break of the rains about the middle of June on land previously exposed to the sun. Exceedingly rapid growth is obtained under such

* Knight, *Proceedings of the Board of Agriculture in India*, 1907, page 105.

circumstances, due to the extremely fertile condition of the soil at this time. The seed germinates at once and the main tap root rapidly reaches the sub-soil, and the young crop is not easily destroyed by a break in the rains. By the end of July a large and bulky crop of easily decomposable organic matter can be ploughed into the soil. The *sann* also possesses the extra advantage of keeping down weeds, and so, not only fertilises the land, but also tends to keep it clean. In addition, the texture of the soil is improved and its moisture-holding capacity enhanced.

The time of planting the cane after *sann* is very probably a most important matter. It is suggested that cane, following *sann* ploughed in for green manure about the end of July or beginning of August, be planted, in Bihar at any rate, *before the end of the following September*, and not later. The reasons for this practice are discussed in detail in the paper on *sann* in this number of this Journal and need not be repeated here. In addition to the advantage of securing the best results from the green manuring, early planting is useful in other ways. Labour and cattle are available at this period and the work can be completed before the preparation of the land for the *rabi* crops begins. In addition, the crop can often be established, without irrigation, on the *bathia* and on the moisture left in the soil by the monsoon. Compared with planting in the hot weather, as is often done at present, the system suggested has great and obvious advantages. Of course, in Bihar the sugarcane land must be properly drained for the work to be done at the end of September, but if surrounded by deep trenches to carry off surplus water, it is surprising how quickly such land is ready for the plough after the monsoon.

In addition to the green manure, such additional applications of cattle-manure or oil cake, as experience suggests, can be applied both before and after planting, and the crop will then rapidly establish itself, in a rich soil in "good heart" and provided with a large supply of moisture-retaining organic matter. By the time growth is stopped by the cold weather of December and January the crop will be well established and in a favourable

condition to meet the vicissitudes of the hot weather. After the cold-weather rains are over, the surface-soil should be pulverised and then covered with a mulch of the lower cane leaves, while irrigation water, where necessary, should be conserved by applying the water by some furrow system instead of flooding the surface.

It is suggested that by growing the crop after *sann*, in the manner indicated, and by altering the planting time, it may be found possible to lengthen the growing period, to cheapen the cost of cane-production, and to increase the yield of sugar per acre. The writer is prevented by the pressure of other duties from trying experiments in the direction indicated, but it is hoped that work may be taken up on these lines both in Bihar and also in the United Provinces. The experiments should obviously be tried on a small scale first of all, after which they can either be extended or not according to the results obtained.

HAS THE FERTILITY OF LAND IN INDIA DECREASED?

By BERNARD COVENTRY,

Offg. Inspector-General of Agriculture in India.

In a past issue of the Journal* some interesting information was published concerning the fertility of the soil in European countries, showing the cause of the increased yield of crops which had taken place in recent years. In this case the information supplied and which had been gathered together by Dr. Cyril G. Hopkins, of the Agricultural Station of the University of Illinois, went to show that the fertility of agricultural land in European countries had very materially increased, principally owing to the use of commercial fertilizers and green-manuring. It has occurred to the writer that a somewhat similar review on the fertility of lands in India would be of interest to readers of the Journal, especially as it has been stated by no less an authority than Dr. Voelcker† that land in India is becoming exhausted owing to the large exports of crops and manures taking place; and more recently the view has been expressed that the yield of crops to-day is less than in the days of Akbar, as given in the "Ain-i-Akbari."

The provincial Directors of Agriculture were therefore invited to supply such information as they could, as to whether, as compared with former times, the fertility of agricultural land in India had increased or decreased. The replies received disclose the great want which exists of reliable data from which to

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* *The Agricultural Journal of India*, Vol. V, Part IV, October 1910, page 383.

† "Improvement in Indian Agriculture," page 39.

draw an exact conclusion; at the same time they do afford a considerable amount of information, both useful and interesting, from which it is possible to form a general and probably correct impression of the comparative fertility of land in former times and to-day. The replies of the Directors will first be given, in synopsis form; after which the conclusions derived from the information supplied will be briefly stated.

United Provinces.—According to Mr. W. H. Moreland, C.I.E., I.C.S., Director of Agriculture, there is no statistical evidence to show any change in the fertility of agricultural land in these provinces. For many centuries it has been a recognised part of the cultivator's art to conceal the amount of his produce from successive Governments, and traces of this fact can be found far back in the revenue literature of the Mohammedan period. The settlement literature of the province gives no grounds for concluding that there has been any general change in fertility within the British period. Particular areas have increased in fertility, notably the land near houses; and particular areas have decreased in fertility owing to known causes, such as interference with drainage; while others again have fluctuated.

A large proportion of the land in the north of the provinces has, within living memory, been brought under the plough, after a rest that probably lasted for some centuries. It would be contrary to all experience that this land should maintain its virgin productivity under continued cropping. Again, a large proportion of the province used to be thrown waste periodically, owing to internal disorder: in Oudh this process went on until less than 60 years ago, and contemporary observers have noted how fertile this land was when it again came under the plough. Thus it is probably true for the greater part of these provinces that the land is less productive now than it was *at some particular period or periods* in the past. But there is no evidence whatever, nor are there any grounds to infer that there has been any progressive decrease in fertility once the period of virgin productivity has passed. On the contrary, in the old cultivated tracts the system of agriculture has been worked out

so as to secure practically constant productivity, on the whole and in the long run.

Bombay.—There is little or no evidence on which a basis of comparison with ascertained yields of the present day can be made. As regards the Bombay Deccan and the Southern Mahratta Country, Mr. G. F. Keatinge, the Director of Agriculture, informs us that throughout the eighteenth century, cultivation in many parts was intermittent, owing to the unsettled state of the country; and it is probable that, at many periods and in many localities, no land, except the very best, was continuously cropped. With the settled conditions and security for property established in recent times, a great increase in cultivation set in, and land was rapidly taken up, till, in the present day, practically all good land has been taken up and is regularly cultivated, and much land that is really unfit for cultivation is also cultivated. This latter class of land produces very poor crops, and of necessity brings down the average outturn per acre. If comparison has to be made with the yields of the present day compared with those of 1830–1870, which was the most prosperous period in the Deccan in recent times, there is plenty of evidence that in those days the cultivation must have been worse.

Madras.—The question regarding the improvement or otherwise in the fertility of land is discussed in a book, published in 1893 by Mr. S. Srinivas Iyengar, late Inspector-General of Registration, entitled "The Progress of the Madras Presidency during the last forty years." He quotes the *Ain-i-Akbari* tables, which give 1,338 lbs. per acre as the average outturn of rice land in the old days. This is much below the return to day for which an average of 2,000 lbs. would not be too much. The estimates of the outturn of cotton made in 1819 by the Commercial Resident of the Ceded Districts, and a manual prepared by the Minister of the Vijyanagram Dynasty, in which the yields of crops will be found, go to prove the same facts. According to these authorities, the yield of cotton in those days was inferior by 20 lbs per acre and that of rice by 1,200 lbs. The experience of Mr. Couchman, Director

of Agriculture, derived from work in the Settlement and Agricultural Departments, is, that lands which are known, from historical evidence, to have been under cultivation from the longest time, are always those which are the most fertile. And further, if the yield from land falls below the point at which it pays to cultivate it, one of two things follows : either the land is allowed to be fallow or it is improved by manuring and tillage. In very fertile tracts, where population is sparse and the rainfall light and precarious, the land is allowed to lie fallow. In either case there is no loss of fertility.

When the country came under British possession, it was a rare thing for land to have any saleable value. It changed hands from year to year, and had to be forced on the cultivators by the Government of the day. Under this system fertility must have been at its lowest, as there was no security to encourage improvements. At the present day, lands in Madras have very high values, due to security of tenure and increase of population, and it would no longer pay, in most cases, to cultivate them, unless they were improved. Mr. Couchman therefore believes that there is every reason to suppose that, as a general rule, the fertility of agricultural land in Madras is greater than formerly, and that the tendency is for fertility to increase rather than diminish.

Central Provinces.—For agricultural purposes the province is divided into three main tracts, *viz.* : (1) wheat tract, (2) cotton tract, and (3) rice tract. There is also a fourth class of land, called light millets tract, which is not of much importance. It generally gets periodical rest by fallowing, and there is no complaint about any deterioration of this soil.

(1) *Wheat tract.*—Mr. Clouston, Deputy Director of Agriculture, Southern Circle, is of opinion that, after the period of virgin productivity has been passed, there is no further deterioration in the wheat lands of the Central Provinces ; they have long since reached a more or less stationary condition of fertility, and variations in outturns from year to year are now almost entirely dependent on seasonal conditions, especially the

rainfall. Mr. Evans, Deputy Director of Agriculture, Northern Circle, is of opinion that newly-broken wheat lands give an exceptional yield for the first six years or so,—when they approach a fairly definite standard, below which the crop does not fall further, but which varies slightly from year to year according to the climatic conditions. The Kurmi cultivators of the Seoni Tahsil are all practically unanimous in saying that the soil is not deteriorating. All of them are agreed that the wheat crops since 1892 A. D. have been much inferior to those of former years, but they are practically all of the opinion that this is due to the difference of climate. The fact that rainfall and its distribution are the chief factors accounting for annual variation in outturn of wheat, is borne out by experiments on irrigated wheat, in which one irrigation in November and another in December gave an increased outturn of nearly 300 lbs. per acre more than the unirrigated plots, in spite of the fact that the land had been cropped with wheat for a long cycle of years, and had never been manured.

(2) *Cotton tract.*—In this tract the yields have improved considerably. This Mr. Clouston attributes to the greater care bestowed on the cultivation of cotton, and also to the introduction of coarser and more prolific varieties. In 1868 Mr. Rivett-Carnac, the then Cotton Commissioner for the Central Provinces and Berar, estimated the average outturn of cotton at 80 lbs. of lint per acre; the present estimate is 98 lbs. for the Central Provinces and 105 lbs. for Berar. Moreover, cotton-growers in Berar, where the plant is sometimes grown on the same land for 10 years or more without a break, hold that the outturn in such fields does not fall off. There is therefore some reason to believe that there is no perceptible decrease in the fertility of black cotton soil in recent times. This is easily explained, for the black cotton soil is of great depth and the cotton plant a deep feeder.

(3) *Rice tract.*—There are no data to show that the production of this class of land has deteriorated. The testimony of cultivators shows that the average yield of rice has been the same for the last 60 years. It is generally believed that this

class of land improves by continuous cultivation, and the outturn perceptibly increases in the case of black (*dorsa*) soil.

Thus, on the whole, there is no deterioration in the soil of the Central Provinces. Some deterioration has, however, occurred in particular cases where lands are liable to scouring and surface wash, and where soils are shallow and resting on poor subsoils such as *murum*. The area under these classes of land is comparatively very small.

Punjab.—As in other provinces, no statistical figures are available by which a comparison of actual outturns can be quoted. The greater part of the land of the province, and especially the canal-irrigated land, has been brought under regular cultivation within the last 100 years, and the fertility of this large tract has increased enormously on account of irrigation both from wells and canals. With reference to the province generally, it is believed that "while the older land cannot be said to have either gained or lost in fertility, the influence of Chahi and Nahri irrigation has enormously increased the productiveness of large areas of land."

Bengal.—Again, there are no reliable figures of outturn from which comparisons can be made. There is no evidence, however, that the fertility of specific pieces of land has deteriorated. On the contrary, there is proof that cultivation, especially in North Bengal, has greatly improved and become more intensive, and that, owing to this improved cultivation, increased yields on specific areas are being obtained. If, on the other hand, attention is paid to average productivity, it is possible that owing to the large increase of land which has been brought under the plough, much inferior land is now cultivated,—which has perhaps lowered the average yield.

Eastern Bengal and Assam.—According to Mr. Basu, Deputy Director of Agriculture, there are three classes of land in this province:

(*a*) Lands which receive an annual deposit of silt from the rivers. The fertility of this class of land depends upon the silt which it receives. On the average it has remained unchanged.

This description of land may form about a third of the total cultivated area of the province.

(*b*) Land under "fugitive" cultivation. This term is applied to the land reclaimed from the forest and cultivated for one or two years. It is then abandoned for an indefinite period of time. This class of land forms a very small proportion of the total cultivated area, and is mostly found in the Assam Valley and the hills. The fertility of this land has remained constant.

(*c*) Land under permanent cultivation. This class of land forms perhaps one-half to two-thirds of the total cultivated area in the province. It is a matter of general knowledge that it has greatly deteriorated since the days of virgin productivity. A great expansion in cultivation has taken place in this province since the restoration of peace under British rule, and the fertility of the land has diminished till it has reached a point where it remains more or less constant. Moreover, with the extension of cultivation, inferior descriptions of land were brought under the plough, causing a depression in the average yield of land. On the other hand, there are conditions which counterbalance this effect to some extent, such as the greater variety of crops grown, the greater prevalence of double cropping, the greater attention which has begun to be paid by the cultivators to the conservation and use of cattle dung, and the greater industry of the tillers of the soil, who have now to keep in line with the continually rising standard of living.

Burma.—From evidence gleaned from Revision and Settlement reports, Mr. MacKenna, Director of Agriculture, is of opinion that there is little, if any, deterioration in the delta lands of Lower Burma. In the neighbourhood of large towns, where cultivation is old and continuous, there has been some deterioration, but, on the whole, the bulk of the cultivation in Lower Burma is so new that there is little evidence of this. Actual statistics of Upper Burma are not available, but the cultivation there is more intensive, and manuring is resorted to, so that deterioration is unlikely.

Conclusions.—What then are the conclusions to be drawn from the information supplied in this article? If we first take up the claim that yields of crops as given in the *Ain-i-Akbari* are greater than those of to-day, a careful examination will quickly convince anyone that the comparison is misleading and fallacious. The yields which are there taken are those from so-called *polaj* land of the time of Akbar. This *polaj* land must have been the cream of the cultivation. Owing to the sparseness of the population in those days, and the heavy revenue collected, the difficulty was to get land taken up, and there is evidence that it had to be forced on the cultivators by the Government; consequently, the best land only was selected for cultivation. It would not be fair, therefore, to compare the produce from picked lands of this nature with that of those under cultivation to-day. In later times the increase both in population and in the amount of land brought under the plough became enormous, owing to the peaceful influence of British rule, and so a very large area of inferior land has been cultivated, as the effect of great agricultural expansion and prosperity. These may have tended to lower the *average* of productivity, but it would be incorrect to say that any deterioration had taken place in the soil. On the contrary, the yields of the present day point rather to an improvement in fertility. This indeed is exactly what we find in Madras, where the outturn of rice is much in excess of that shown in the *Ain-i-Akbari* tables. Cotton too has greatly increased. Mr. Couchman's conclusions are that the fertility of agricultural land in Madras is greater than formerly, and that the tendency is for it to increase.

In the cotton tracts of the Central Provinces and Berar, yields have increased 22 per cent. in the one case, and 30 per cent. in the other; and there is evidence that, in the rice tracts, lands actually improve by continued cultivation. In the wheat lands at Pusa, the yields in recent years have progressively increased, with no more aid than weathering, fallowing and an occasional rotation and green manuring. In North Bengal too the yields and value of crops among cultivators have very considerably improved.

While therefore it has to be admitted that there is no statistical evidence to show what change has taken place in the fertility of land in India, there is yet plenty of evidence of another kind, not only that it has not deteriorated, but that it has actually improved.

With regard to the contention, based on chemical grounds, that a country which exports the bulk of its crops and manures must be declining in fertility, the evidence and arguments already supplied prove it to be entirely fallacious. It ignores two important points: (1) That the Indian system of cultivation is extensive, and that the cultivator is shrewd enough never to bring his land to the point of exhaustion, but by a judicious variation in rotation of crops, in which the leguminous order comes prominently into play, and by weathering and fallowing, he strikes the happy mean by which his land is always ready to produce the next crop, provided the rain or water is there to supply moisture. (2) That the recuperative power of the land in India is very great, and that the biological factor is all-important as an agency for the supply of plant-food. This is partly due to the physical nature of the soil, but is also accounted for in great measure by the climate, which, in combination with tillage, creates the conditions favourable to the continuous production of crops.

It may perhaps be necessary to answer here the question, which may be anticipated, and which will naturally occur to the interested enquirer, why is it, if the fertility of the land in India is not on the decline, that the yields of crops per acre as compared with foreign countries are so low? There are many limiting factors in crop production, such as the physical conditions of the soil, the climate, water-supply, period of growth, etc., which control the weight of produce per acre. But assuming most of these factors to be constant, there is one which varies considerably and yet has a vast influence on the results, and that is the amount of capital employed. No comparison between the rate of production in India and foreign countries is of any avail unless account is taken of the capital invested. In

India, as has already been explained, farming is extensive, and little capital is used; the cultivator being content to reap low average returns by a well regulated and economical system of rotation of crops and tillage. Abroad, farming is intensive, and much capital is used. Hence, the result is, for example, that while in England the yield of wheat per acre is 33 bushels, in India it is about 12 bushels. The rate of production therefore will depend, in any country, mainly upon the amount of capital employed, and the productive power of the soil will necessarily vary accordingly.

To summarise :—

(1) There is no progressive decrease in the fertility of agricultural land in India, once the period of virgin productivity is passed, but, on the contrary, the fertility of Indian soils has been more or less in a stationary condition, with a tendency to improve under better treatment.

(2) The *Average* of productivity may have become lower, owing to inferior lands having been taken into cultivation on account of the great agricultural prosperity and expansion brought about by the peaceful influence of British rule, but this does not mean or imply that the objective fertility of the soil has become less.

(3) India's rate of production is low compared with Western nations, mainly due to the amount of capital employed being small. If more capital is used, the rate of production will be greater.

THE ECONOMIC RELATIONSHIP OF SHEEP DIPPING.

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Introduction.

In continuation of a previous article in the *Agricultural Journal of India*,[1] I should like to make some further remarks on the practical methods and the economic value of sheep and cattle dipping.

Objects.

The objects of dipping are :—

1. To remove ecto-parasites from the skin, hair or fleece, so that animals may have greater comfort and thereby improve in condition.

2. To benefit the fleece, thereby increasing its marketable rate, and giving a higher value to the hides of cattle by preventing the damage done by ticks.

3. By the destruction of these parasites and their eggs, in order to prevent many of the diseases of which they are the carriers.

[1] For references see page 72.

I will take these in sequence :—

1. Concerning the first, it is well known how animals infected with ticks, lice, ringworm, and scab will continually rub and bite themselves, and drag their wool against every available object in their endeavour to remove the irritation. They are unable to sleep in comfort, and stock-owners realise that animals continually worried cannot properly feed. Apart, therefore, from the mechanical damage and loss to the wool,[2] acute emaciation is often the result. All these factors militate against the animal deriving efficient benefit from its food-supply or putting on condition. They have a detrimental effect on meat production and the breeding of healthy robust young stock. If the mother of a lamb is in a poor state throughout pregnancy, it is impossible for the lamb to be born in a normally healthy and vigorous condition.

2. The damage done to the fleece, not only by the parasites themselves, but also by the irritation they induce, causing the sheep to rub themselves continually, dragging out the wool as they do so, has a pronounced effect on its marketable value. The poor condition so induced in the sheep will also influence the quality of the clip, as one cannot expect a poor animal to grow as good a fleece as a well-conditioned one. It is fully recognised in tanneries how much the value of hides in sheep and cattle is depreciated by the attacks of ticks.

3. The loss occasioned by Piroplasma, more familiar under the name of "Red Water," a disease which is conveyed through the medium of ticks, is well known. Professor Nuttall [3] has pointed out the possibility of ticks (Hyalomma ægyptium) being a means of conveying Hæmorrhagic Septicæmia Spirillum or Recurrent Fever is also tick-borne. Although not brought so forcibly to one's attention, the damage done by the maggot fly (*Bengalia depressa*) is very great.[4]

Sheep scab and ringworm are very serious affections.[5] Lice have been demonstrated as the intermediate hosts of the dog tapeworm (*Tænia cucumerina*), and it is possible that they may play the same part for some of the tapeworms affecting sheep

and cattle; we have as yet a very limited knowledge of the intermediary stages of the tapeworms affecting these animals. The enormous extent to which Indian cattle and sheep are the victims of intestinal parasites is a matter for very serious consideration. The flea has been shown to be an active agent in the dissemination of plague in man.[5] Neumann[2] says that only the dog, cat, rabbit, pigeons and fowls harbour fleas (Pulex Serreticeps or Leporidæ), but at certain seasons of the year, in India, it is very common to see the legs of cattle and sheep swarming with them.

The flea, like the louse, is an intermediary host of tapeworm, and it is quite probable that they both take an active part in the dissemination of bacterial disease also. Apart from this, the mechanical irritation which they set up renders their presence very undesirable.

The so-called sheep *ked* (*Melophagus ovinus*), a wingless fly, is another parasite whose ravages are destructive to the skin and its appendages, and cause discolouration of the wool. Then there are the many varieties of Gadflies (Œstridæ), which give rise to the condition known as "Warbles" in cattle, "Bots" in horses and "Maggots" in the nostrils of sheep.

Controlling Effect.—All the above-mentioned parasites and diseases may be controlled by "dipping:" in many cases they may be absolutely prevented, and in others, such as "Warbles," they can be combated to a very considerable extent. As already pointed out, it is not only the mechanical irritation and annoyance that these parasites set up which claim attention, but the far more dangerous and fatal diseases of an infective nature to which they are capable of acting as intermediary hosts. Although it cannot be expected that dipping will act as a universal panacea, it may at least so modify the ill effects, that the disease is rendered controllable.

Application of Dipping.—The introduction of dipping into India would no doubt involve some trouble, but the results would be worth it. As explained in the article already referred to,[1] individual sheep farmers do not own very large flocks,—that is,

in comparison with those of the big graziers of the Argentine, Australia, etc. Public dipping baths under State control, as in Australia and New Zealand, would therefore be necessary, and dipping rendered compulsory as it is in those countries, a rule which is welcomed and entirely agreed to by all stock masters. [6] Of course, baths would have to be erected at various centres, so that the operation could be carried out under proper supervision and with efficiency. In the Transkei, in South Africa, which is farmed almost exclusively by natives, dipping is enforced, and owners have to bring their animals to the centres at specified times, when the operation is carried out under the supervision of Inspectors.

Practical Application.—With regard to the application of the process, the points to be considered are :—

1. The class of dips to be used.
2. The best bath.
3. The time of year to administer the bath.
4. Supervision and method of application.

I will again take these points in categorical order :—

1. *The Class of Dip.*—In deciding on this important matter, there are several things to be considered : (*a*) the dip must be cheap, (*b*) and easy of application ; (*c*) it is not only to kill skin parasites and their eggs, it should also prevent a reinfection by these parasites for a considerable time : (*d*) it must be portable, *i.e.*, it should take up as little room as possible, in order to facilitate its transit before mixing for use ; (*e*) it should improve the wool—at least, it must do no harm to it or to the sheep and cattle ; (*f*) it is essential that it should not hurt the hands of the men who have to apply it.

Advantages of an Arsenical Dip.—Experience has shown that the above qualities are best combined in arsenic, which is the basis of the majority of the so-called poisonous, proprietary dips. It is cheap and is not bulky, and, when scientifically mixed, it is the most destructive of all the dips to parasites and their eggs ; through its non-absorbable nature it is not dangerous to animals

to which it is applied It has not, when ordinary care is used, any deleterious effects upon the hands or constitutions of the men who apply it. Stockman, when Chief Veterinary Surgeon in South Africa, and Lounsbury, Entomologist to the Cape Government, as the result of their experiments on this subject, [7 & 8] have chosen this agent as the best that can be employed. Mr. Gilruth, Chief Veterinary Surgeon in New Zealand, informs me that arsenic is universally used in that Colony, and that its use is followed by the best results. Williams, Stock Inspector, South Australia, thinks that arsenic is the best, and has the most lasting effect, of all the dips.[9] Verney is of the same opinion.[10]

Substances such as carbolic acid, tobacco, stavesacre, so-called non-poisonous dips, and other parasiticidal substances, are more expensive, more difficult of application, less efficient in their action, do not give so long protection from subsequent attacks of parasites, and are not so effective in the destruction of eggs.

At the classic trial of sheep dips in New Zealand,[11] the most satisfactory appeared to be an arsenical dip (Cooper's), although "Thomas' Carbolised Composition" approached it very nearly. It was there shown that these dips killed skin parasites and gave the longest immunity—animals being free from ticks several months after, although with carbolised dips reinfection had taken place—and that the wool sent to market was in good condition and unstained, and really fetched better prices than wool from sheep that, although they had no parasites, had remained undipped.

The reports of important wool buyers, such as Johnson and Viears, and Martin & Co., concur in saying that the fleece from dipped sheep is better than that from undipped animals. In fact, it is said that growers cannot realise within one penny per pound as much for undipped wool as they can for the dipped fleece. The freshness of yolk of dipped wool is superior, and its spinning qualities are improved. This is so well recognised that many stock-owners in Australia dip every year, whether their animals are free from parasites or not.

Trial Test.—The following is the result of a trial with two kinds of dip, with a "control" of an undipped sheep—State Agricultural College, Colorado.[12]

	Weight at time of dipping.	Weight after 3 days.	Weight after 15 days.	Weight after 35 days.
Arsenical dip ...	42 lbs.	43 lbs.	46 lbs.	50 lbs.
Liquid dip (Carbolic) ...	52 ,,	49 ,,	50 ,,	58 ,,
Undipped ...	47 ,,	47 ,,	49 ,,	53 ,,

Result of Test.—It will be seen from the above experiment that the sheep dipped in the arsenical mixture commenced to gain in weight at once, that the carbolic dipped sheep lost weight, and that the undipped sheep remained as they were. After a period of 35 days the arsenically dipped sheep showed an increase of 2 lbs. more either than those dipped in Carbolic or those left alone. Hutcheon and Lounsbury, in their experiments carried on at the Cape, [13 & 14] have also confirmed the beneficial effects of arsenic.

Arsenical Dip.—The particular dip tested above is a proprietary article, composed of a mixture of arsenic and sulphur. The bath is made by mixing the powder with a given quantity of water. The powder, being in a fine state of division, forms a bland emulsion and, being so held in suspension, penetrates to the skin of the animal. Its lasting effect is due to the fact that a considerable amount is precipitated in the fleeces, and on the skin, at the actual time of dipping and during the evaporation of the water; it thus not only kills the parasites while it is in the fluid condition, but prevents subsequent attacks.

Fluid Dips.—The application of carbolised fluid dips or those made from tobacco, etc., where there is a solution, does not act in this way, and the after effects are nil as soon as the animal is dry. The fact of arsenic being non-absorbable allows of its being made use of in this way, whereas the former, which are easily absorbable, cannot be so used.

Comparison of agents used.—The immediate action of arsenic is probably not so quick as that of some of the fluid dips; but, as I have explained, its lasting effect is greater, and even if

female ticks are not killed outright, they are so injured as to prevent reproduction. It does not appear to be necessary to use an elaborate mixture, as is done in the Frontier dips of Queensland. Here the arsenic is boiled with a proportion of carbonate of soda, which renders the arsenic soluble; tar oil is added to increase the germicidal action, and, in order to obtain a bland emulsion, soft soap is dissolved, which renders the dip sticky, so that it may remain wet upon the animal for a longer time. In comparing the many accounts and reports as to the efficacy of dips, it would appear that simple powdered sulphur and arsenic are quite as successful when thoroughly mixed and suspended in water, as are the compounds of oil. They would appear also to have a greater power of improving the wool when alone, and to have no deleterious effects on either the sheep or its fleece.

Agents.—The following is a useful formula for a dip bath[15]:

White Arsenic (Arsenious Acid)	...	...	...	20 lbs.
Soda Ash	...	...	...	20 „
Sulphur	..	...	...	2 ozs.
Soft Soap	..	...	...	4 lbs.

Dissolve in 4 gallons of boiling water, then add sufficient water to make up to 50 gallons: this should be enough for 50 sheep. Aloes may be added to colour the fluid so that it is not mistaken for water, and will render it bitter and unpalatable to the animals.

Also—

Arsenite of Soda	...	..	...	5 lbs.
Aloes	...	...	...	12 ozs.
Soft Soap	...	...	...	5 lbs.
Water	...	...	...	100 gallons.

This saves the mixing of arsenic and soda, as the arsenite is soluble, prevents the sheep licking themselves, acts as a vehicle by making a soft emulsion, and prevents the dip from drying too rapidly.

Here it is necessary to boil the arsenite of soda with the aloes and soft soap in order to get a good solution. The cost is therefore very much enhanced. The fact that the arsenic is in solution increases the probability of its absorption, and prevents it from being so efficient, subsequently, as a preventive against reinfection.

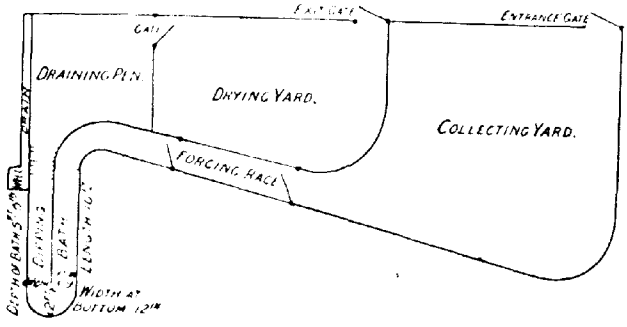
The cost of dipping in arsenic and sulphur is less than a half-penny per head.

The best baths.—In considering the form of bath to be used, it is necessary to decide as to whether it would be for sheep only or for cattle also; in the latter case a very much larger bath must be used. A reference to the plan will give a very good idea as to what is required, much better than any description. The erection of such a bath on the lines given, can be carried out by any intelligent workman. The tank itself, and the draining yards, should be of concrete, the posts and rails of good strong wood, and the covers of the tank galvanised iron in wooden frames. If intended for sheep only, a much simpler form of bath may be used, either fixed or portable. A plan of a portable bath is given in Plate III, Figs. 1 and 2. In a small bath such as this, a large number of sheep can be dipped in the course of a few hours, and the whole appliance can be removed very rapidly.

If it be required to erect a permanent bath, a good form is that figured in the plan given on p. 63. Here space is economised and the sheep have to stop and turn in the bath, an essential matter in the efficient dipping of long wools, when, if the animal continues to swim in a straight line, the fluid presses against the fleece which, acting like a thatch, prevents the fluid from getting down to the skin. If, however, the animal be checked, the wool floats outwards and forwards, allowing the fluid to penetrate to the skin surface.

There should always be a sloping ramp, made with bars across, as in a duck run, to prevent slipping, up which the animals can walk out of the bath. This should lead on to a confined yard

THE DIVIDED SWIM BATH FOR SHEEP AND GOATS.



The merit of this design is that the partition down the middle of the Bath gives the same length of Swim at but little more than half the cost. A Bath 10 feet long and 3 feet 9 inches wide will afford 20 feet of Swim.

THE BATH may be any length over the minimum of 10 feet. Its width at top from wall to wall should be 3 feet 9 inches, its depth 5 feet 6 inches. Its sides should go down straight until within 2 feet 6 inches from the bottom, and then slant inwards to a width of 12 inches at the bottom. The concrete walls should be 6 inches thick, and recesses left in them as per paragraph below.

THE PARTITION extends to 2 feet from the end, to enable the sheep to turn and be headed round the opposite side to the exit. It should be made of 3×2 studs, with $\frac{1}{2}$ in. or $\frac{3}{4}$ in. match lining nailed on to their narrow sides. Ends should be left to the studs, to permit them to be sunk into hollows left for their reception in the concrete at the bottom of the Bath. Along the top of the partition should be nailed a piece of wood 3×2, and the height should be level with the top of the Bath, so that a cross piece of wood fixed on to the end of the partition, may rest in recesses on the tops of the concrete walls to keep all firm. The opposite end of this top plate should fit into a recess from the concrete at the head of the Bath. The partition can at any time be lifted out for repairs.

THE DRAINING PEN should have a slanting waterproof floor so that the wash may run down to the side drain and thence into the well.

THE DRAINING WELL should not be less than 2 feet square, and its bottom should slope 18 inches from the inlet corner, down to the lower or exit corner. The wash is strained through a piece of perforated iron (with $\frac{1}{4}$ or $\frac{3}{8}$ inch holes) which is placed diagonally across, fitting close on to the bottom. The dirt accumulating should be frequently removed.

THE CONNECTING PENS may be variously arranged, those given in our design being considered the most convenient.

IN DIPPING, the sheep should be passed through the Forcing Race into the Bath, and in heading them round the dividing partition, each sheep should be detained long enough to insure a thorough soaking.

in which they are kept for 5 or 6 minutes, to allow of the fluid dripping off them. Here it falls on to an impervious floor (in the case of a sheep bath, corrugated iron does very well) which is drained so as to admit of the fluid either running back into the bath or into a waste tank. A grating of trellis is a good thing to place over the iron, it prevents animals slipping, and allows droppings to fall under it, so that they do not stand on moist filth. Outside this dripping yard is a larger corral in which they can be kept until they are practically dry, when it is safe for them to return to the pastures. If it is deemed advisable that the dip should remain moist upon an animal for a longer time, especially in a climate where rapid evaporation takes place, soft soap may be added in the proportion of 16 lbs. to 100 gallons of fluid. The necessity of continually stirring the dip, in addition to the agitation caused by animals passing through it, is evident from the fact that every sheep, as it leaves the dip, takes away some of the fluid, and there is a tendency for the emulsion to become more concentrated. This is especially the case when a waste tank is used for the drippings, instead of allowing them to run back into the bath. The objection to allowing them to run back into the bath is that they become soiled with the droppings of animals in the draining pen.

Time of year.—The best times for dipping are, the autumn, following which the sheep are kept clean throughout the winter; and up to the time of shearing in the early summer. A further dipping should be effected one month after shearing, this latter being the most important.

Supervision.—It is essential that the person superintending the operation of dipping should have had some practical experience. If carried-out properly, it is comparatively easy, and attended with no danger; but if some of the minor, although necessary details be omitted, considerable trouble is likely to arise.

Details of method.—Some of the main points to be observed are the following. Always mix the dip thoroughly and in proper proportion. If any intervals occur in the dipping, stir up the

PLATE III

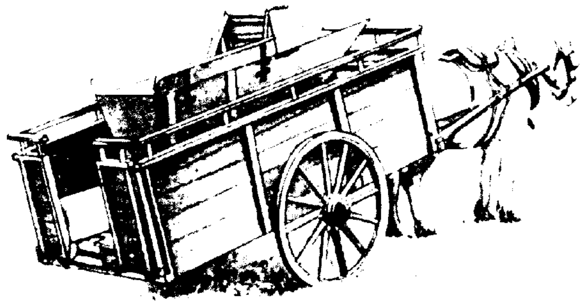


FIG. 1. THE [illegible]

It would be an easy matter to [illegible]

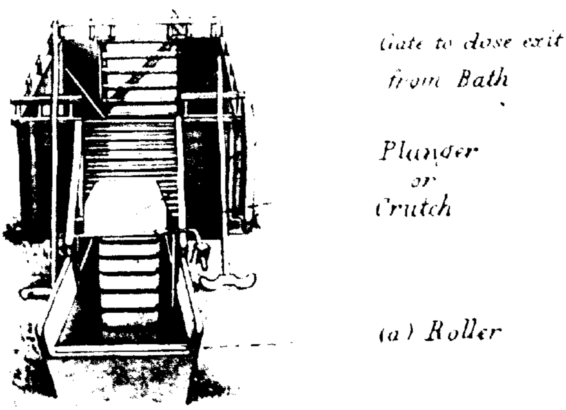


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FIG. 2. BATH READY FOR USE.

(Showing gate open)

Holes are dug for the wheels and the Bath which are afterwards used for the draining away of the dip.

bath in order to keep the powder in suspension and of uniform strength throughout. The mere movement of animals through the bath is not sufficient to keep the powder suspended; this must be done with what is known as a "Plunger," *i. e.*, a long piece of wood with a flat disc at the end of it. The mixing also prevents the scum collecting on the top of the water, which otherwise tends to settle on the backs of the animals as they leave the bath. This scum contains a large amount of arsenic, which, mixing with the inevitable dust, makes a mud cake on their backs as they become dry, and may eventually cause a piece of skin to slough off, leaving a sore.

For ordinary dipping 1 minute in the bath is sufficient, but if the sheep have scab, 2 minutes is necessary: for this affection [16] a second dipping may have to be given.[17] A second dip with arsenic should not be given until an interval of 15 days has elapsed. Sheep should never be dipped when they are hot, or after a long journey; they must be left several hours to cool and rest, and should also be given the same rest after dipping, in the shade if possible. In a hot climate, such as that of India, the operation should be carried out in the early morning, or in the evening in the hot weather, as too rapid evaporation tends to irritate the skin, and may even cause the wool to fall off in patches. Dipping in wet weather should be avoided, as drying is inhibited, and, the powder being washed from the skin, the subsequent good effects are partially nullified.

The plan adopted for placing sheep in the bath is simple. For the small bath (Plate III, fig. 2) the sheep are lifted, and slid on their backs over the roller (a) so that their hind feet strike the fluid first, and they sink to the bottom of the bath before gaining their equilibrium sufficiently to swim. The men handling the sheep should be instructed to drop them carefully and not to throw them in so as to endanger their legs.

In the case of the divided swim bath the sheep are driven along the race, those that are behind forcing those in front to jump into the fluid, from which they swim out. The long handled piece of wood, already mentioned, may be used for pressing

down the sheep, so that their heads are well dipped and they may be kept in the requisite time. Practically the same rules apply to cattle, but it is not necessary to check them in the bath, as their hair is so much shorter.

To obtain the capacity of the bath, multiply the length by the breadth by the depth in inches, and divide by 277,—*i. e.*, the number of cubic inches in a gallon of water,—the result will be the capacity of the bath in gallons. As a bath always has a slope on the one side, the cubic capacity of this triangular space must be taken separately. The fluid never reaches to the top of the bath, so that measurements should be made to within 1 to 1½ feet of the top, care being taken to fill to that mark when mixing the dip. The reason for not filling the bath completely is that the displacement caused by the first batch of animals entering, would cause unnecessary waste and the impregnation of the ground, surrounding the bath, with the fluid.

If a proprietary arsenical dip be used, the amount of fluid required to each pound or packet will be given in the directions; and the same applies in the case of a fluid dip such as Little's, Macdougal's or Tuson's.[13] If the dip is made up as required, the proportions will be as those already noted, as in the dip used in the Colonies, and the other formulæ already given.

The operation being finished, the bath should be covered up and securely locked, as the dip may be used again. If, however, much filth has accumulated, or it is not again required for some months, it is better to let it drain away into a hole dug for the purpose. If arsenic has been used, it should not be allowed to remain on the surface of the ground, or anywhere where animals or people are likely to congregate. I need scarcely say that this dip is destructive to plant life, and, for this reason, it should not be spread on the ground unless it is to be used as a weed killer, in court-yards, etc., with proper precautions.

Comparisons.—I have assumed that the method of dipping is that of a swimming bath or plunge. This is doubtless the most economical and efficient method. Other means, however,

have been advocated, such as applying the agent by means of a brush or spray. As a means of destroying ticks these methods are tedious and, for the latter, very expensive. For the spray, use kerosine or tar oil and water. The oil can only be efficiently mixed with the water by reducing them both to a fine state of division and spraying them while they are in this state. This is done by using a force pump, which ejects the two through a nozzle. It will be understood that this is much more expensive and less satisfactory than a plunge bath. Other agents composed of tar oil, carbolic acid, etc., are, on account of their pungency, sometimes useful in individual cases, as in their application for the prevention of the settling of flies upon animals, in Surra-infected districts. As a dip, I do not think they are as good as arsenic.

The other methods of applying parasite-destroying agents are smearing, and pouring oleaginous or saponaceous compounds of turpentine, tobacco, etc., on the fleece or skin of animals affected with Scabies, Ticks, etc.[19] They are applicable only where a small number of animals are concerned. They are expensive and inefficient where large numbers have to be treated, and have been entirely superseded by dipping.

The use of a mixture of lime and sulphur has been advocated: here great care is required in the proportions used, for if there is an excess of lime, the wool is rendered brittle. The proportions used are 20 parts of sulphur to 10 of quick-lime and 100 of water. Boil the sulphur and lime in 25 gallons of water, for two hours, so that there is a complete chemical combination of the lime with an excess of sulphur; then add the remainder of the water. The compound is an evil-smelling one: it tends to darken the wool and is very troublesome to prepare. Carbolic acid is used in a solution of 2·5 per cent. It is absorbable, easily washed out, shrivels and reddens the wool, and is therefore not recommended.[20]

Tobacco and sulphur in combination are considered good, but the mixture is expensive and difficult to prepare. The proportion is 10lbs. each of tobacco and sulphur and 60 gallons of water. The tobacco is steeped for 24 hours, then raised to 100°

C. (212° F.) and allowed to cool for 12 hours, pressed, strained and mixed up thoroughly with sulphur, made into a smooth paste and then the correct quantity of water gradually added and stirred in. The wool is not damaged, but the lasting effect is small, and men suffer considerably from headaches and nausea when applying it; moreover, the quantity of nicotine in tobaccos, grown in different localities, varies so greatly that no estimate as to the correct strength can be made.

Coal tar products such as Lysol, Creolin, etc., are not sufficiently permanent in their effects; they are absorbable, and are said to harm the wool. The impure products of coal tar are efficient for a short time. A mixture of 3 pints each of coal tar oil and dead oil to 50 gallons of water, makes a useful dip: but it is a filthy mixture, evanescent in its effects and absorbable. It would also be expensive in India, as would any of these combustible materials; and their power of destroying eggs is very doubtful.

There has been considerable hesitation as regards the use of arsenic, on account of its poisonous properties. If, however, reasonable precautions be taken, no poisoning need be feared. As already explained, animals must be allowed to stand in the dripping yard until the fluid ceases to fall from them, and a careful disposal should be made of the finished dip. Animals that plunge into the bath head first, never take any quantity of the fluid in by the mouth, their instinct prevents that, unless they are wilfully pressed into the fluid to the point of suffocation. As it is absolutely non-absorbable by means of the skin, it is considerably safer than are many of the carbolic and coal tar products, or than the so-called non-poisonous dips.

In the treatment of some exceptionally bad cases of Scabies, it has been found necessary to scrape and rub the scabs from the skin, and at the same time apply one of the fluid carbolic dips such as Little's, Tuson's, etc., and then to submit the animals to the arsenical swim dip. This is a common practice in the Argentine, and it saves the two dippings with a 15-days interval

which are sometimes necessary for the complete eradication of scab.

Conclusions.

From the foregoing advocacy of dipping sheep in India, it must not be concluded that this procedure is going to induce these sheep to produce the best wool in the market: such a contention would be absurd. No dipping or treatment will bring up the long hairy fleece of an Indian animal to the quality of that of a highly bred Merino or Lincoln long wool; at the same time there is no doubt that it would vastly improve it, and this improvement would be very noticeable in the first year. The clip from each sheep will be at least 1lb. more if the animals are not tormented by skin parasites. As a result of the better conditions under which they will live, they will be in better health, and, to use a technical expression, the fleece will have a better "tip" and contain more "yolk." The result of this would be a rise in price of 1 penny per pound, and, in addition, there would be the extra amount of wool. Allowing that the price now realised for wool is 6*d*. per pound, and each sheep at a shearing averages at the lowest estimate 3lbs., the result of dipping would be an increase to 4lbs., and an increased value to 7*d*. per pound. It is a matter for the statistician to work out what the gain would be amongst the millions of sheep in India.

The cost incurred in dipping each sheep would be only ½*d*., which of course should be deducted from the above. The amount expended in the erection of dips would be an investment from which interest would be derived out of the profits accruing. The question of improvement to the wool is, however, not the only consideration. There is the better condition of the sheep, causing it to be a more useful meat-producing article and quicker in fattening. In my previous article in the *Agricultural Journal of India*,[1] I pointed out the enormous amount of waste that must exist amongst sheep, owing to their not being cared for sufficiently to render their meat suitable for a profitable canning or freezing industry. Again, with regard to the improvement to the wool, competition with S. American, Australian and S.

African producers cannot be equally entered into, because no efforts have as yet been made to breed good wool-producing animals. Large sums of money are yearly spent by sheep-growers, in the above-named countries, in the purchase of highly bred English rams—of stud animals which come of a stock that is noted for the high class quality of their fleece. There is no reason why India should not compete on equal terms. If that is to be done, however, breeders must be induced to import, or to breed by selection, high class wool-bearing animals. The Indian sheep is big-framed, and only requires care to produce both good mutton and a good clip; this can be done by selection in breeding. Much money has been expended on horse-breeding, and the results are, to say the least, not very encouraging; but a proportionately very small amount of the annual expenditure that this involves, would suffice to make a very material difference in the sheep industry, and give advantageous pecuniary results.

It is satisfactory to note that experiments are being made at the Hissar Farm, in sheep-breeding, and that a consignment of Merino rams was obtained recently from Australia, by the Civil Veterinary Department, and distributed in the Lughman Valley, Bikanir and Hissar. The dipping experiments could be made in some of the tick-infested areas. These would have to be conducted over a somewhat extended district, in order that the effect on the distribution of skin parasites may be determined. It would be a very good plan to take a number of villages, and arrange for animals being dipped in certain areas and not in others; an estimate as to the efficacy and benefit derived, could then be arrived at by comparing the one with the other. In all probability, the prices realised by the wool in one district, as compared with those obtained in the other, would be manifest in the first year.

I have already said that there are numerous small difficulties connected with the operation, and that it would be advisable to have it supervised by some one acquainted with its minutiæ. If one of the proprietary dips were used, the administration would

'be very much easier ; as the simple method of mixing obviates the necessity for boiling, etc. For the total destruction of ticks, a dip will no more succeed than it will in causing Merino wool to grow on an Indian sheep. It will, however, if properly used in tick-infested areas, cause a very considerable diminution in the number of these pests ; and will, in course of time, keep them within such bounds as to render them practically harmless. The stamping out of ringworm, lice, and even scab, should be absolute.

In connection with the prevention of "Red Water," which is conveyed by means of ticks, it may be pointed out that, in Australia, not only are the ticks destroyed by dipping, but immunity is given by infecting animals with a small dose of virulent piroplasmic blood, before they are taken on to a badly-infected tick area. This immunity is produced by inducing a mild attack of the disease from which the animal recovers. Its power of resistance is thereby so increased that it is enabled to withstand a very large dose of poison, which the bites of numerous ticks would convey. This, in conjunction with rigorous dipping regulations, has now rendered the country in Northern Queensland habitable for stock. The former method is obviously impossible in India, not only for caste reasons, but also because the whole country is infected with piroplasma.

It cannot be expected that one year is going to bring about a very radical change ; close application and a thoroughness in detail would be necessary for some time ; but I am quite convinced that if an intelligent combination of dipping and breeding were applied to the Indian sheep, the improvement, in a very few years, would be such as to repay all the outlay in capital, and return a big margin of profit.

Acknowledgments.—I wish to express my thanks to Sir Richard Cooper, M.R.C.V.S., and his sons, for so kindly showing me all the latest pattern dipping baths, and for allowing me to reproduce their excellent drawings of these appliances.

I am greatly obliged to Professor Woodhead for the interest he has shown in this paper.

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THE INFLUENCE OF ROOT DEVELOPMENT ON THE TILLERING POWER OF CEREALS.

By A. E. PARR, B.Sc., Ph.D.,

Deputy Director, United Provinces.

Growers of cereal crops recognize that good soil requires a smaller quantity of seed per acre than poor soil. The thin sowing is more than made up for by the young plants "tillering," or sending out numerous side shoots which develop along with the main stem. The general belief is that the extent of the tillering is in inverse proportion to the quantity of seed sown or, in other words, leaving out the quality of the soil and seed, the amount of space allowed to each plant is the limiting factor. If a plant has a large area on which it can draw for its food, it will develop more tillers than a plant with less space at its disposal because it is in a position to absorb more food, and thus to develop more energy. At the same time research of the last forty years has shown that, if a certain maximum of space is exceeded, undesirable results will follow, because the plant tends to continue its vegetative development when the whole of its attention is required for the formation of seed. The younger tillers are frequently only partly developed when the seed of the older stems is ripening. An uneven ripening of the crop results, and often on account of the large quantity of half ripe, shrivelled grain the whole sample is reduced in value.

The ideal of the farmer is to sow his grain at such a distance that a certain amount of tillering will result, but not so much as to bring in the above-mentioned disadvantages. If the crop is not tillering as much as desired, harrowing is usually resorted to.

It is generally understood that a plant takes in a large proportion of its mineral food in the early stages of its growth, and this is the period when root development is at its height. In the second stage of the plant's life carbon assimilation and consequent rapid development of the stem and leaves are the outstanding features. Root development is not so active. The third stage is when the seed is being formed. The roots are called upon for supplies of mineral matter, particularly phosphorus, and in cases where the tillering has been very pronounced the roots may not be able to supply enough material to properly develop the young seed.

The above is a rough outline of the data available to Demtschinsky when he began the investigations which have created so much interest in the agricultural world of Continental Europe during the last three years. He has carried on a large number of experiments to show that, if root development is stimulated, no disadvantages follow from extensive tillering. His methods have led to saving of seed and to increased yields per acre. The investigations were carried on in Russia, at first with winter rye and wheat, and later with spring sown oats and barley, and from them it is clear that the root development of cereals can be increased considerably by—

(1) transplanting in a particular way;

(2) earthing up.

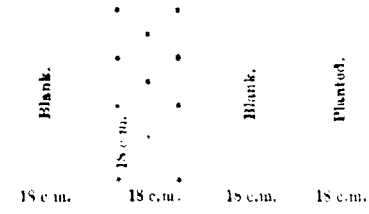
Transplanting of cereals is a recognized practice in China, and this with other intensive methods of agriculture enables the country to support an enormous agricultural population.* Demtschinsky has attempted to adapt the Chinese method of transplantation to European conditions. It is interesting to follow his experiments and recommendations and to watch the evolution of a practical method.

He dealt first of all with rye and winter wheat. The seed was sown in nurseries about two weeks before the normal time

* It may be mentioned that single transplantation of wheat seedlings attracted some attention in England more than a hundred years ago.

for sowing the crop, and when the seedlings were three weeks old, they were planted out in the field. The field was divided into strips 18 centimetres wide, and alternate strips were planted. Three rows of plants were put out in each strip and the plants were 18 centimetres apart in the rows.

The illustration below makes the matter clear.



At the places where the plants were to be put in, holes were made and the young plants inserted in such a way that they were 1½—2 inches deeper in the ground than when in the nursery. This allowed the lowest nodes to be covered with earth and these nodes then develop adventitious roots. By this method Demtschinsky obtained enormous yields on good land, as much as 8,000 pounds of rye per acre being recorded, and many of the plants had 60—70 stems all bearing well-developed ears. This method has since proved profitable and practicable on some of the small Russian holdings where the whole of the work is done by the peasant and his family. In addition to a considerable increase in crop there is an initial saving of 75 per cent. of the seed ordinarily required.

It was quite apparent from the first that this method is useless for dealing with large areas on one farm. Demtschinsky therefore began experiments in earthing up drill-sown plants with a small plough. To make this possible, he sowed three lines of winter wheat, leaving a distance of 3 inches between each line. Then a strip was left blank in order to make earthing up possible (*see* diagram, p. 76). The width of this strip varied. Where a horse was used to draw the plough, 10—11 inches of space was left. Where a hand Planet Junior was used, less

space was necessary. Earthing up with the latter gave excellent results.

Blank for earthing up.	Wheat sown in three lines.	Blank.	Sown.

Twenty to thirty days after sowing, the plants were earthed up to a height of $1\frac{1}{2}$—2″ at one operation, or still better, two earthings up of 1″ each were given at an interval of about 20 days. High outturns were obtained by this system, although considerably less than by deep transplantation.

These results were then communicated to the press and were soon in the possession of agriculturalists in all parts of Europe. A large number of people became interested in the matter and eventually several practical ways of arriving at the desired goal were devised. The name of Zehetmayer is closely connected with one of the most important. Instead of sowing on the flat and earthing up, he recommended a ridge and furrow system. A drill, with a small ridge plough attachment in front of, and a roller attachment behind each seed spout, makes the ridges and furrows, sows the seed and compresses the bottom of the furrows all in one operation. When the young plants are about 20 days old, a roller with projections on it like the peg drum of a thresher, and with a harrow attached behind, is drawn over the field and levels down the ridges, thus earthing up the young plants in the furrows. The roller is necessary to reduce the soil to a fine condition as it is essential that only fine soil should be thrown round the young plant. Later on another rolling and harrowing are often given, or if the ridges have completely disappeared, the young plants are sometimes earthed up with a hand Planet Junior. The system above described is popular with many. But where the rainfall is heavy, furrows are not in favour. The crop in such cases is sown in the ordinary way about 8″ apart and then earthed up.

Demtschinsky's results came before the public in 1908. Since then three harvests have been gathered, and his system with its modifications has stood the test satisfactorily. Not only is an increased outturn of grain obtained, but the strength of the straw is increased, and crops are less likely to go down.

It is interesting to notice how close the open furrow system of Zehetmayer approximates to the common method of sowing wheat in many districts of the United Provinces and the Punjab. By means of a special plough with a bamboo attached the seed is buried deep in the bottom of a furrow. The ridges on each side are not interfered with by roller or harrow.

Last year I began an experiment with wheat at the Aligarh Farm along Demtschinski lines. Unfortunately an attack of white-ants on the plots concerned, prevented any useful results being obtained. This year I made some observations on maize which are of interest here. Two plots of maize were sown side by side. In one the seed was sown on the flat, in rows two feet apart. Later on, the plants were earthed up as is usual in maize cultivation. In the other plot the seed was sown at the bottom of furrows about five inches deep. The furrows were two feet apart. When the plants had reached a height of 15", the furrows were filled up. All through the growing season the crop on this plot was much bigger and healthier than on the other plot. It suffered less from drought, showed much more root development and ripened six days earlier. The cobs were picked direct from the field and weighed before drying. The outturns per acre were as follows :—

	Mds.	Seers.	Ch.
1. Sown on the flat	28	37	8
2. Sown in furrows	47	15	0

I have attempted only a very brief description of the main points involved in Demtschinsky's teaching. Full information can be obtained from his books "Die Vervielfachung und Scherstellung der Ernteerträge" and "Die Ackerbeetkultur, ihre Grundlagen, Methoden und neuesten praktischen Ergebnisse,"

published by Paul Parey, Berlin, 1909 and 1911, respectively. An interesting discussion of the subject, from the points of view of the practical farmer and of the plant breeder, has taken place in the "Deutsche Landwirtschaftliche Presse," and to this paper I am indebted for much of my information.

GREEN-MANURING WITH SANN

By ALBERT HOWARD, M.A., A.R.C.S., F.L.S.,

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THE importance of the monsoon to India is well known and it is clearly recognised that the prosperity of the country depends on the recurrence of this annual phenomenon. In tracts where the rains are generally scanty and also in those in which they sometimes fail altogether, extensive protective irrigation schemes have been and are being carried out by Government agency. In this manner the shortcomings of the monsoon are greatly mitigated, and vast regions of India are protected from famine and from the partial or entire destruction of its agricultural population. The irrigation policy laid down in the *Report of the Irrigation Commission* can be regarded as a recognition of the agricultural fact that in many parts of India water is a limiting factor in crop production. The writer believes that it is possible for the Agricultural Department to extend this policy and to show that the rainfall and irrigation water now available can be used to much better advantage, and can be made to produce much larger crops.

In the conservation of soil moisture for the benefit of crops two methods are open to the agriculturist. In the first place, the loss of soil water by evaporation from the surface can be minimised by various systems of surface-cultivation and by the application of mulches. In the second place, the moisture-holding capacity of the soil itself can be increased by the addition of organic matter. The present paper will be confined to a consideration of the importance of increasing the amount of organic matter in the soil by green-manuring.

Among the crops available for green-manuring in India, *sann* (*Crotalaria juncea*, L.) possesses many advantages. It is commonly a *kharif* crop and is thus grown at a time when rainfall is available for its growth and also for its subsequent decay and incorporation with the soil. *Sann* grows very rapidly, chokes all weeds and, moreover, does not require any special soil preparation. The rapidity of germination and the rapid growth of the tap root enables the crop to reach the subsoil moisture quickly and to survive without difficulty a break in the rains.

The earlier results obtained at Pusa with *sann* as a green manure for tobacco were published two years ago and attracted considerable attention. The method has since been taken up widely by planters and cultivators. The further experience gained at Pusa with this crop as a preparation for tobacco during the last two seasons fully bears out the earlier results. For tobacco *sann* should be sown at the break of the rains preferably in land which has previously been exposed to the sun. The fertility of the soil is greatly increased by hot weather cultivation and, moreover, is in the best condition to absorb all the early showers. The seed is sown broadcast at the rate of 30 seers per acre and buried to the required depth by a spring tine harrow, after which the soil is levelled by the *sohaga* or *hanga*. A single pair of good cattle with a spring tine harrow will sow about 3 acres a day, or more than four times the work accomplished by the country plough. The crop is first rolled and then ploughed in with a small Hindustan or other iron plough about the middle of July, and left for about three or four weeks to decay. Tobacco is planted out about the third week in September and, if possible, established on the *hathia* rains, or, if these fail, by means of furrow irrigation. In the plate opposite two tobacco plots are shown, the left green-manured with *sann*, the right with old tobacco leaves and stems. The photograph was taken on November 10th, 1909, and both plots were transplanted on September 20th. The increased growth of the *sann* plot is extraordinary, and it is not surprising that this cheap manure has been taken up by planters and cultivators on

a large scale in Bihar. Similar results have been obtained at Pusa during the last two tobacco seasons, and there is every reason to believe that green-manuring with *sann* for tobacco in Bihar is now becoming a well-established practice, especially on lands which cannot be treated with indigo *seeth*.

The experiments with *sann* on tobacco at Pusa in 1909 indicated further that there is a time-limit in green-manuring, after which almost negative results are to be expected. The first indication of this time-limit was observed in November 1909 on a plot of tobacco land in the Botanical area which had been green-manured with *sann* in the manner indicated above. One corner of this plot was planted out towards the end of September, while the rest was kept for some experimental tobaccos which are not usually planted out till the first half of November. There was therefore a difference in time between the two plantings of nearly seven weeks. An extraordinary difference manifested itself between the early and late plants. Those planted out in September grew rapidly and produced magnificent plants. Those planted late behaved as if they had been set out in unmanured land. The growth was slow, the leaves were pale in colour and small in size and had the stunted appearance of tobacco grown without manure. The results of course were affected by the temperature factor, but compared with other plants set out late on manured land, the late plants on the *sann* plot were very poor. The difference between the late and early plants on the *sann* plot could therefore not be accounted for by the temperature factor. The results seem to be explicable on the assumption that a loss of fertility follows green-manuring if the interval between ploughing in and sowing is too long.

A further experiment on this subject was made in 1910. Two plots of tobacco land were green-manured with *sann* in the ordinary way and a control plot received a moderate dressing of rape cake instead. Late tobacco was planted in both plots in the first half of November and the growth was compared. The results of 1909 were again repeated. The plants on the *sann*

plots grew slowly and produced small and yellow leaves as before, while the crop on the rape cake plot was exceedingly vigorous. In the same year, when the interval between ploughing in *sann* and planting the tobacco was two months, a magnificent crop was produced. These results appear to indicate the existence of what may be described as a *time-factor* in green-manuring with *sann*, and it is possible that the negative results often obtained are due to the existence of this factor. It may be that for every crop the time-factor will have to be worked out, and that the interval between ploughing in the green-manure and sowing must be carefully regulated. Possibly the amount of cultivation after ploughing in the *sann* is also important.

As to the causes underlying the time-factor, in the case of tobacco, nothing definite can be said. The matter should be investigated from the bacteriological and chemical standpoints. It is suggested also in all future green-manuring experiments in India, especially where negative results have been obtained in the past, that the time-factor be taken into consideration.

Another aspect of green-manuring with *sann* is being investigated at Pusa. This relates to the best manner of burying the green crop. Should the *sann* be completely ploughed in, half covered or cut and left on the surface? These matters principally affect the heavier lands on which the general experience is that green-manures have less effect than on open sandier soils. Possibly a part of the result may be due to moisture retention. Sandy soils need some moisture-retaining substance much more than heavier soils. There is, however, another aspect of this question as far as heavy soils are concerned. It is well known that if heavy lands in Bihar, into which *sann* has been turned in, are subsequently inundated, the next crop is exceedingly small and poverty-stricken and the yield is less than if no green-manure had been applied. Possibly on heavy lands the *sann* should be cut and left on the surface to rot and only turned in, say, a month afterwards. It is well known that fibre plants ret more quickly if left to wilt for a few days before immersion than if placed

in the water at once. It is possible, therefore, that *sann* will decay faster if it is cut, and then buried after some days than if ploughed in at once in a fresh condition. So far, definite results on these points have not yet been obtained at Pusa, but there are indications that on heavy land it may be found best to let the *sann* crop lie on the surface for a time. It is expected that the figures of these experiments will be available for publication shortly.

Enough has been said to show that such an apparently simple operation as the ploughing in of a green-manure crop involves many considerations, and also indicates the need both of careful field experiments accompanied by detailed and accurate records, as well as laboratory investigations from the chemical and biological standpoints. It is suggested that, where negative results have been obtained in the past, the real cause of the want of success may be found in the time-factor having been overlooked or in subsequent water-logging of the land. In all such cases the work should be repeated. The importance of increasing the water-holding capacity and fertility of the soil is so great in India, and green-manuring is such an easy way of bringing this about, that no pains should be spared to find out experimentally the factors on which success depends. In addition to the field experiments it is also desirable that the matter should be investigated from the chemical and biological aspects. Best of all would be an exhaustive study of the subject by an investigator who combines within himself the necessary agricultural experience and insight along with bacteriological and chemical knowledge. It is more than likely that such an investigator would produce results which, instead of furnishing a scientific explanation of well-known agricultural methods, would lead practice and so place the whole subject on a higher plane.

A PROFITABLE TYPE OF COTTON FOR THE WESTERN DISTRICTS OF THE UNITED PROVINCES.

By A. E. PARR, B.Sc., Ph.D.,

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ALIGARH was originally selected as a suitable place for an Experiment Farm, because it is situated in the centre of the most important cotton-growing tract in the United Provinces, and therefore affords facilities for the study of the cotton crop. The six adjoining districts of Etah, Agra, Muttra, Aligarh, Bulandshahar and Meerut grow, normally, about 750,000 acres of cotton each year. All the above named districts have extensive canal and well irrigation systems, and in seasons when the monsoon rainfall is scanty as much as 50 per cent. of the cotton area is irrigated to a greater or less extent.

There are two fairly distinct seasons for sowing cotton in this tract. Some 25% of the total is sown in May or early June on land irrigated from canals or wells. The remainder is sown when the monsoon begins. Cotton sown early on irrigation is usually removed in November or early December, and if rain has not recently fallen, the land is irrigated, then ploughed and a crop of barley and peas sown. Cotton sown on land not commanded by irrigation remains on the field some time longer, and no other crop is possible till the following monsoon. Cotton usually follows a cold-weather cereal crop. After the cereal crop is harvested, the village cattle wander over the fields and weeds and stubble are thus removed. When the time arrives for sowing cotton no plant refuse is to be found. After irrigation or rain the cotton seed is sown broadcast and then ploughed in.

No effort is made to obtain a fine seed-bed. In May and June hot winds blow continuously, and if several ploughings are given, a great loss of moisture results and another irrigation is necessary before sowing. When the monsoon begins, the cultivator immediately rushes in his crops and has little time or inclination to prepare a tilth. As a result of sowing broadcast a rather irregular stand of plants is obtained.

Ten pounds of good seed per acre is the usual quantity and good cotton land will yield 800 pounds of * Kapas per acre. Cotton is very frequently grown associated with other crops, the chief of which is *arhar* (*Cajanus indicus*). Hibiscus cannabinus is also commonly seen in cotton fields and frequently a creeping pulse is also sown. Over the whole of this tract one species of cotton is cultivated, namely, Gossypium neglectum† Tod. but four different types of this species are easily noticeable in most cotton fields, differing in the colour of the flower and the form of the leaf. The flowers are either yellow or white and the leaves either deeply or slightly dissected. The types with the slightly dissected leaves are not common. They are not regarded as very productive by the cultivator. Practically the whole of the crop then is composed of a mixture of white, and yellow flowered types with deeply dissected leaves. Of these two types the yellow flowered one predominates, white flowered being present in quantities varying from 1—20 per cent. of the total. These two types have been carefully studied at the Aligarh Experiment Farm. At first by careful selection pure types were obtained and these were grown side by side for comparison of outturns. White flowered cotton has up to the present always yielded more "Kapas" per acre than yellow. The average excess over a period of two years has been 19 per cent.

In addition to its high yield of "Kapas" the white flowered type has a high ginning percentage, yielding between 39 and 40 per cent. "rui," whereas ordinary yellow flowered cotton yields about

* "Kapas" is seed cotton, "rui" is cleaned cotton.

† See *Agricultural Journal of India*, January, 1911, article by Martin Leake and Parr.

33 per cent. The cotton is as a rule slightly better in colour than that of the yellow flowered type, but has a somewhat shorter and coarser staple. On account of its high ginning percentage the local merchants are willing to pay about 10 per cent. more for white flowered "Kapas" than for the ordinary crop. They are in fact quite willing to pay in proportion to its ginning percentage, if a considerable quantity is placed at their disposal. They have not yet shown any disposition to seriously criticize it on account of its coarser staple. Taking all the above points into consideration, it is undoubtedly a much more paying crop than is the slightly adulterated yellow flowered type which is grown at present, and on this account it is being recommended to the cultivators.

At the beginning of this season white flowered cotton seed was distributed in small quantities to a large number of villages in the Aligarh district. The crop is now practically over, and growers are reporting strongly in its favour. Large indents for seed for next year's sowings are already being received from villages which gave it a trial this year. It is hoped that enough seed will be available to sow about 2,500 acres in the coming season. An attempt will be made to get a large part of this area grown in villages near the farm. The growing crop will then be easily supervised, and a large quantity of pure seed will be obtained for wider distribution in the following year.

A PRIORI SUGGESTIONS FOR A THEORY OF THE INCIDENCE OF INSECT PESTS IN AGRICULTURE.

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When the balance of nature is rudely disturbed, an oscillation is set up which, when it results in a rapid increase in the numbers of an insect at a critical time, may cause the loss of a crop. It should be possible to shew, in a general way, how such oscillations occur under agricultural conditions and how the disturbing factor can be counteracted.

The cycle of life on the earth consists, firstly, of the accumulation of potential energy in the building up of organic matter by plants through the action of sunlight; and, secondly, in the utilisation of this energy by "animals" that feed on plants and by other "animals" that feed on the first, and so on.

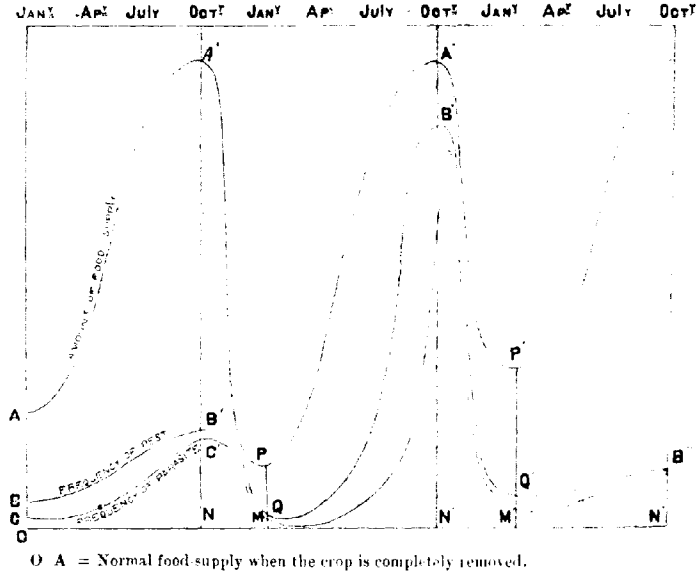
Other conditions being favourable, the abundance of any particular "animal," an insect for instance, depends on two factors :—

1. The abundance of its food-supply.
2. The abundance of the "animals" that prey on it—its enemies.

In order to arrive at any theory of cause and effect it is necessary to work from a simple case, and to assume that any complications that may occur in practice, can be superimposed without affecting the principle arrived at. Let us take the case of an insect feeding principally on one important crop and its wild relatives, and preyed upon by one species of parasite which lives solely on this particular insect.

When the pest is multiplying rapidly, we have a large area of its food-crop growing, which may be represented by the curve A A′ on the diagram, the ordinates drawn from the base line vertically to meet the curve at any date representing the amount of food provided by the crop and its wild relatives for the pest at that date.

Now, supposing the pest to have reached its condition of normal frequency—when its numbers, as measured by the amount of food consumed, bear a constant relation to the amount of the



O A = Normal food-supply when the crop is completely removed.
M P = The supply as affected by abnormally unfavourable circumstances, *e. g.*, by Frost.
M′ P′ = Do. Do. favourable circumstances.
N B′ = The damage supposed to be done by the insect in a normal year—say 20% of the full grown crop NA′.
N′ B″ = The damage supposed to be done after a winter of abnormally low food-supply—80% of the crop.
N′ B″ = Will vary more or less inversely as MP.

food-supply at a time before the crop is cut, the occurrence of the insect may be represented by the curve B B′; and, if the parasite has attained the same condition of equilibrium, its frequency can be denoted by C C′.

The growth of the crop now ceases, and the crop is removed, leaving only stray plants, and the food-supply is reduced to

these and any wild plants on which the pest can feed and which grow later in the season. The curve will now continue as drawn beyond A′, B′ and C′, the curve B "lagging" behind A, and the curve C behind B, because the rate of increase of each factor is dependent on the absolute magnitude, and not on the rate of change of the factor on which it depends, continuing for a certain time after the magnitude of the factor on which it depends has begun to decline.

The result will be that at certain points P, Q, soon after the crop has been removed, unless the pest and parasite pass into a resting stage almost at once, the pest will almost entirely have exhausted its food-supply and the parasite will have reduced the pest to the point of extinction.

But when such a point of great scarcity has been reached the occurrence of both insect and parasite must become local and sporadic, the pest will not find all the food-plants, nor the parasites all the individuals of the pest, and the normal ratios of frequency will be upset: in some places there will be food-plants but no pest or parasites: in others, there will be food-plants and pest but no parasites, and in others again, food-plants, pest and parasites in normal or less than normal proportions. *But in few places can there be pests in numbers disproportionate to the food-supply or parasites in numbers disproportionate to the pest, because any such disproportionate increase, with a locally limited supply of the host, would result in the rapid exhaustion of the host in that place, and the starvation of the pest or parasite.*

This, then, is the condition of affairs at the end of a cropping season, and we start a new season with the pest occurring locally and abnormally rare, and the parasites still more local, and abnormally rare relative to the numbers of the pest. Whether at any considerable time after the crop is cut both pest and parasites pass into a state of hibernation is immaterial.

The deductions so far arrived at can be verified or proved incorrect by obtaining statistics of the actual occurrence of the insect pests of important crops, and of their parasites.

If they are true, the curves of frequency of the pests and their parasites will commonly follow that of the food-supply in some such manner as is shewn in the diagram, converging rapidly as the crop is cut till the frequency of all three factors is reduced to the point of sporadic occurrence; diverging about that point and until the next food-crop begins to grow, and converging again towards the period of normal occurrence at some point in the growing period of the crop. Such oscillations are consistent with all periodic movement, and are, on general grounds, exceedingly likely to occur,—the motive power in this case being the sudden removal of large areas of the food-supply. But the amplitude of these oscillations will depend on the relative importance, to the pest concerned, of the crop removed, compared to that of other plants on which it can feed. There may be relatively few plants on which the pest can feed during the time when the crop is off the ground, as in the case of insects feeding exclusively on one family of plants, members of which are commonly grown as crops only at one season, and are rare in uncultivated ground, owing to climatic or other reasons Under these circumstances the occurrence of both pest and parasite may become at times exceedingly rare, the food-supply being confined to odd plants that survive until the resting period, if any, of both pest and parasite arrives. The oscillation of the curves of frequency of the pest and its parasite will then be increased, the divergence of the curves after the point of sporadic occurrence is reached being relatively great, and in some cases it will be so great that the normal ratio of frequency of the parasite to that of the pest is not reached until so late that the crop is irretrievably damaged by the relatively unchecked spread of the pest, as is shewn in the middle year of the diagram.

To take an obvious instance, it is possible that the damage periodically done to cotton by bollworm in the Punjab is due to the sensitiveness to frost of malvaceous plants, and to the relative rarity of the cold-weather annuals of this natural order in the drier parts. The extended growth of Hollyhocks in sheltered

gardens, *e.g.*, of canal bungalows, might accelerate the recrudescence of the caterpillar and parasite at the end of the cold season, and so decrease the "lag" of the latter which tends to the destruction of the cotton crop.

If the theory here suggested holds good, the principle in accordance with which agriculturists are sometimes advised to combat insect pests by attacking them at their weakest point, is a mischievous one, for such action would still further aggravate the local dispersion at that time, of the factors concerned.

From this point of view a study of the conditions favourable to such parasites, as factors of positive economic value, is of primary importance, and would reduce the danger attaching to the use of the little knowledge we now possess of the causes of the periodical devastation wrought by insect pests.

NOTES.

Unfavourable influence of Grass on the Growth of Fruit Trees.—(Etwas vom Einfluss des Rasens und eines ungünstigen Untergrundes auf das Wachstum von Obstbäumen). *Geisenheimer Mitteilungen über Obst-und Gartenbau*, XXVI Jahrg. No. 1, 3 figs., pp. 2-5. Wiesbaden.

Near Darmstadt, Mr. Goethe observed several plum trees, planted in soil which was very sandy on the surface, that were in a bad state of vegetation. Two of them, which were in a meadow, were uprooted, and their roots were found to be very little developed and superficial; some of them were brown in colour, and, when cut, presented a reddish brown section.

A tree in a neighbouring field, of the same species and nearly of the same age, was, on the contrary, in an excellent state of vegetation, although the soil was of the same nature. It had, however, been tilled, instead of being left in grass.

Mr. Goethe thinks that the marked inferiority of the first trees was due to the soil's being covered with grass, and he suggests that the soil round fruit trees should be tilled and grass never allowed to grow. (Bulletin of the Bureau of Agricultural Intelligence and of Plant Diseases, Rome, 1911, page 325).

A previous note on this subject will be found on page 373 of Vol. V of this Journal. There is an accumulation of evidence that, on light soils, the growth of grass under fruit trees, especially in the case of young trees, is very injurious.

* * * * * *

We have been favoured with a copy of a speech delivered by the Kumar Rajah of Challapalli, at the Cattle Agricultural and Industrial Show held at Ellore in February 1191, from which

we quote the following passages of general interest :—"It appears to be true that the ryot realises much profit nowadays from the produce which he raises in his land owing to the prevalence of high prices, after deducting the necessary agricultural expenditure; but it is equally true that he lays by very little. Under these circumstances some additional drain on his purse comes in, in the shape of performance of a marriage or other ceremonial to some member of the family; construction of a substantial building for his own use or that of his cattle, incurring the necessary medical charges if a member falls sick; meeting the expenses of a ruinous suit, or of spending money for the expenses of cultivation—when such contingencies arise, he is perforce driven to the clutches of the sowcar or money-lender, to meet this extraordinary expenditure by borrowing at a usurious rate of interest, ranging from 12 to 36 per cent. When once a ryot contracts a debt, however small it may be, he will be postponing repayment until he finds himself heavily involved. To free the ryot from the thraldom of indebtedness and of the prementioned evils, the best remedies appear to be the development of Co-operative Credit Societies; the introduction of the Panchayiti system; the extension of high ideals of life and sympathy; and the creation of mutual trust, confidence and conciliation.

"The benevolent British Government have not been slow, from time to time, to feel the responsibility of rendering help, or in other words of mitigating the baneful consequences of indebtedness so far as it could, for which several enactments have been devised. In times of distress and want, the Government lent money on easy terms of repayment for the purpose of sinking wells, repairing tanks, and for the general expenses of cultivation. They had a special Agriculturists' Relief Act in the Deccan, from which the ryots did not derive much benefit. There used to be a Usury Law at the beginning of the last century to protect them from a high rate of interest, but it was repealed as its application did not bring any relief to the peasant, as the money-lender employed all sorts of stratagems to defeat

the purposes of the Act. All these efforts having ended in failure, the Government of Madras appointed, in 1892, Sir Frederick Nicholson, to make a tour in foreign countries, with a view to see how they solved this problem and to suggest some scheme fit to be introduced into this country. On his presentation of a scheme and after much correspondence, the Act X of 1904, the Co-operative Credit Societies Act, was passed. Since then the popularity of the measure is best seen in the annual increase of societies, and in the amount of capital invested therein, as noticed from the reports of the Registrar published year after year, and from the highly interesting one for the last year, published only recently by the talented and painstaking Registrar, Diwan Bahadur R. Ramachandrarau. From the following figures for the whole of India, we see how the movement as a whole is making steady progress, and how full of promise they are for the future development of the scheme. The number of societies rose from 1,300 in 1908 to 2,000 in 1909, and to 3,500 in 1910. The number of members rose from 180,000 to 230,000, the capital from Rs. 80 lakhs to Rs. 124 lakhs, and the deposits from members from Rs. 16 lakhs to Rs. 25 lakhs. . . . . .

"The question of financing these co-operative societies next claims our deepest thought and attention, as it is attended with some difficulty, though not unsurmountable. As we all know, most of the members that may likely join these societies are men of limited means, and consequently will not be able to raise the necessary funds by their own cultivations. The local money-lender will naturally view these concerns with a step-motherly affection as they come in the way of his amassing large fortunes by a usurious rate of interest, until a time comes when he finds himself surrounded by a keen competition, by virtue of which he must reduce his rate of interest, and throw in his lot with the many. And, therefore, it is an acknowledged thing that, in the initial stages of operation of these societies, they will have to have recourse to outside help in the form of loans from, or deposits by, non-members like the philanthropic

millionaire or the benevolent rich zemindar, or from any banking institution. In thus going in for outside individual help for the needful funds of the society, it seems that the efforts would not always be met with success, as the individual capitalist or the banking institution feels shy of advancing large sums to the societies whose financial stability is not assured to them. To provide for a ready means of financing them, a valuable suggestion, from a worthy quarter, has been thrown out in the shape of instituting a Central Bank with a large capital, outlay under a sharing and dividend system. In my humble opinion, this institution, though it might work beneficially in the beginning, may in the long run, develop into a regular banking business with purely pecuniary considerations of turning out large dividends. When this stage has been reached, it cannot but work hardly upon the poor co-operative societies. The best way of supplying funds to them is to institute Joint Stock Companies with a limited liability, to lend money solely to them, in every district, or in a central place for two or three districts put together, as the case may be. In this connection the memorable words of Sir K. Seshadri Iyer, uttered in his speech to the members of the Mysore Representative Assembly in 1894, are worthy to be quoted. 'On the one hand,' says Sir Seshadri Iyer, 'we have large accumulations of amassed capital in the country, as evidenced by the balances in the Presidency and other Exchange Banks, the refusal of the former to receive any private deposits except as current ones carrying no interest, and the high premium which the Government of India 3½ per cent. securities command. On the other hand, we have the agriculturist suffering from inability to raise the funds required for his *bonâ fide* purposes except at usurious rates of interest. . . . . How to bridge over the wide gulf that thus separates capital from want, is one of the most important problems of the day in this country.' Thus we see the most important problem that presents itself to us for solution, is how to bridge over the gulf that separates capital from want, or in less ambitious language through what means or

vehicles are we to bring about a line of communication between the amassed wealth of the country and the abject poverty. I am sure you will all agree with me if I say that the Co-operative Banks or Credit Societies may serve as the chief vehicles for establishing a line of communication, if they are well constituted, and organised on a working basis. To the money-lender and the rich zemindar, they form the best source of investment, as the money invested is well secured by the combined, as well as the individual liability of the members of the societies: and to the latter it is a matter of two-fold advantage; for besides replenishing his coffers with the interest on the money invested, he will have a substantial, solvent, and self-satisfied peasantry instead of a poverty-stricken, famished, and discontented one. . . . . "

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WITH THE PERMISSION OF THE AUTHOR AND THE PROPRIETORS OF THE PLANTERS' CHRONICLE, BANGALORE, we print the following passages from an interesting lecture on Fungi, delivered by Mr. McRae, Mycologist to the Madras Government, before the United Planters' Association of Southern India, and printed in the Planters' Chronicle of the 2nd September 1911.

"A fungus is a plant. As you know, a plant may consist of a single small cell or of several cells. The plants with which we are familiar are made up of a great many cells grouped together in various ways. This can be seen quite well with the aid of a low power microscope. These cells contain the living matter of the plant called protoplasm. Green plants have, in addition, a green colouring matter embedded in their living substance. This colouring matter acts as a sort of screen to absorb the radiant energy of the sun's rays. This enables the protoplasm to take the simple inorganic substances, like nitrates and phosphates which the plant has absorbed from the soil through its roots, and like oxygen and carbonic-acid gas which it has taken in from the air through its breathing pores, and to manufacture from them complex chemical substances, like sugars

and starches. Then the plant uses these sugars and starches for its further growth and development.

"A fungus also requires these complex chemical substances to enable it to grow and develop. But a fungus has no green colouring matter in its cells like the higher plant. It cannot make its food for itself, from simple inorganic substances in the soil and air. It has to get its food already manufactured. The only things that can manufacture their own food-supply from the simple constituents of the soil and air are green plants. The obvious thing for a fungus to do, then, is to use the matter contained in the bodies of green plants, after they are dead. The bodies of animals, which are really dependent on green plants for their food-supply, is a second possible source of food for fungi. As a matter of fact, fungi utilise the bodies of both plants and animals. Those that feed on dead bodies we call saprophytes. They are, as a rule, beneficial, in that they help to dispose of these dead bodies, and in this way act as scavengers; but they may cause some annoyance and loss: when, for example, they occur, as moulds, on stored grain or eatables like cheese and fruits. Such fungi, however, it is easy enough to keep in check. But, not content with using dead plants and animals as a source of food, some fungi have learned how to invade the tissues of living plants and animals, and to extract food from their living cell. Such fungi we call parasites. They are prejudicial: especially as they attack and kill plants that are of economic value to us. There is an intermediate class of fungi which can attack some living plants, or, if necessary, can live on dead vegetable matter. These may be called 'possible parasites.' Such fungi are among the most difficult to deal with, when they assume the parasite habit and get a good hold of a crop, because, when they have killed their host plant, they are able to go on living and to produce further stages of development on the dead bodies of their host.

"A few of the simpler problems fungi have had to solve in assuming the parasitic habit are (1) how to get inside the body of the plant: (2) how to get inside the cells of the plant where the

food is made and stored ; and (3) how to get their own reproductive parts (or spores) distributed.

"Let us take the first problem, namely, how to get inside the body of the plant. You all know that fungi produce spores, or germs, that are blown on to green plants or that reach them in some other way, as on the bodies of insects that fly from plant to plant, or on the implements used in cultivation. Let us start then with a spore. In its simplest form it is a single cell. It may, however, consist of 2, 3, 4, 10, or more cells united together. It may be a thin-walled spore that requires a longer or shorter period of rest before it begins to grow. The diversity of form and adaptation of spores is great, and is an interesting subject, to which we must not, however, digress. A spore gets on to the outside of a plant. In suitable conditions of warmth and moisture it germinates, *i.e.*, from a part of its surface it sends forth a thin tube called a germ-tube, and into this tube the protoplasm or living substance passes. The tube grows on the outside of the plants and gets inside the body of the plant either through the breathing pores, which are natural openings, or it bores through the outer covering of the plant by producing a ferment at its tip which dissolves the cell-walls. Now it is inside the plant's body, and it has still to decide how it is going to get inside the cells, in order to get at the food-material of the host-plant. Some fungi go straight ahead in a business-like way. At the tips of their fine tubes they produce a ferment which dissolves the cell-walls and allows the tubes to enter the cells and get at the food-material. They may bore their way out in the same way as they got in, and then bore into the adjacent cells. Other fungi are more delicate in their method. The tubes once inside the body of the plant grow and branch in the spaces between the cells, where there is plenty of air. From parts of the surface of their branches a ferment is secreted which dissolves the cell wall, and the fine tubes grow into the cell and act as suckers to absorb the food inside the cell of the host-plant. Other fungi, again, simply place their tubes in close contact with the cells of their host-plants, and absorb food through the cell-wall, without

actually penetrating the cells. One group of fungi, the mildews, have decided not to go inside the body of the host-plant at all. They remain on the surface and simply send suckers into the cells below. Now that the fungus has access to a plentiful supply of food, it develops rapidly, and its presence usually causes some modification in growth or structure of the host-plant. Such changes are most diverse, varying, from minute modifications of a single cell, or of a small group of cells, to those changes, which give rise to relatively large deformities, such as clubroot of cabbage, pocket plums and cankers.

"As a rule, the fungi with which we are familiar in our economic plants gradually ramify through the cells of the whole plant. Not only is there a drain of food-material from the host-plant, but the fungus actively kills the cells into which it grows, or into which it sends suckers, and ultimately causes the death of its host. Hence a fungus has to make provision for the continuance of its species after the death of its host-plant. This it does by producing spores. It would obviously be an advantage to produce the spores in the outside of the plant, for they could then be more readily distributed to other plants, than to produce them within the plant, for then they would have to wait till the plant decayed and disintegrated before they could be released. Fungi have discovered this, and as a rule they do produce the spores on the surfaces of their host-plants. This is the stage when the fungus usually first becomes visible to the casual observer. This is not, however, the first stage. The fungus has been inside the plant for days, weeks or even months, doing its work in a silent way. It has been destroying and feeding on the tissues of the plant. Picking off the fruit bodies of a fungus will not destroy it. People often ask me why it is, that when they pick off fungus fruit-bodies whenever they appear, the plant attacked never seems to get any better. They do not realise that fruit-production is a late stage in the life of a fungus, and that the host-plant is full of the fungus even though it is not easily seen. Fruit-bodies of fungi vary. Some fungi send out single threads, or little groups of threads, to the surface and they

either pass out through the breathing pores, or they bore out. Then they produce spores at their ends. Usually, however, some provision is made for the protection of spores while they are developing, by many threads growing together to form some sort of a fruit-body. Fruit-bodies are of the most varied descriptions. You are all familiar with the mushroom, which is the fruit of a fungus which grows underground on decaying leaves, twigs and roots; and with a bracket fungus such as *fomes* on rubber, which is the fruit of a fungus which lives inside the tree, gradually destroying and absorbing the tree's tissues, till it has gained strength and vigour enough to produce fruits. Fruit bodies of fungi are diversified to the most wonderful extent, and it is by this feature, together with the form of the spore, that the individual species of fungi are recognised. The number of spores produced by an individual is usually great. It has been calculated that a single mushroom discharged 1,800,000,000 spores in two days, or about 40,000,000 per hour, and that a single parasitic bracket fungus, a species of *fomes*, produced about 11,000,000,000 spores, and this was only one of a group of about ten on the same tree. Such numbers are inconceivably large. Since it may be assumed that the number of fruit-bodies of any given species remains fairly constant from year to year, except in times of epidemic, these give us an idea of how many of the spores die and how few, in nature, ever find a suitable place for successful development.

"To the planter and the mycologist parasites are, perhaps, the most interesting of fungi. The planter wants to know how to keep them off the plants he cultivates; the mycologist wants to find how they have solved the various problems presented to them in their adaptation to the parasitic life. Fortunately, the two interests harmonise, for, in tracing out the life-history of a parasitic fungus, one is able to spot the weak point in development, at which it is most susceptible to outside influence, and to direct the attack at the proper time and place. It is here that the labours of a trained mycologist are of value to planters. Investigation of the life-history of parasitic fungi is a specialised

study. They are small organisms and require continued use of the microscope. A well-equipped laboratory is also necessary for the preparation of media and means for the isolation and study of artificial cultures, and for the study of the relationship of fungus and host. This work has become more and more important in recent years.

"There is available, at the present time, a considerable amount of information about the diseases of Southern India, chiefly in writings of officers in Ceylon and the Malay Peninsula. Much, however, still remains to be done in Southern India on these very diseases. In addition to their life-histories, we want to know a great deal more about their seasonal occurrence, of how they are influenced by the various changes of climate and rainfall that occur from place to place and from year to year. Besides these, there are quite a number of diseases of not inconsiderable importance about which we know nothing at all. The field for investigation by a mycologist is a wide and interesting one, and his studies, resulting in the discovery of efficient means for reducing the damage done by parasitic fungi, will be of much profit to planters.

[The reported order of paragraphs in the *Planters' Chronicle* has been changed here at the author's request.—EDITOR.]

* * *

NOTE ON A MUSTARD OIL PRESS SEEN IN JESSORE DISTRICT.—During a tour in Jessore district in the cold weather of 1910-11, the writer came across several old oil presses. One such was seen at work, and perhaps a note on its work may not be without interest, especially as financially it seems to be very successful. The press I saw belongs to Mr. H. C. McLeod of Kotechandpur, Jessore, and he very kindly gave me a few notes and figures. It had only been working for the previous 6 months and before that had been lying idle since 1898.

The press is very old and of a clumsy pattern and bears no maker's name on it. There are 12 crushers in line, and each crusher consists of a heavy iron pestle resting in an iron mortar in which the seed is placed. The mortar is caused to revolve

and the seed is crushed by the weight of the pestle. There is an iron scraper, which is stationary, which rests in the mortar in such a way as to stir up the seed as the mortar revolves: attached to the lower part of the mortar is a reservoir into which the oil falls. A hole in the side of the reservoir allows the oil to escape and it falls on to an iron plate fixed below. This plate has a spout on it, and the oil is run off into buckets. The oil is strained into big metal drums, and allowed to stand. In 3—4 days the oil is quite clear and is poured off from the sediment. The sediment is again placed in the mortar, generally being added to mustard seed when the crushing process is half done. During the crushing process a very strong mustard oil smell pervades the air. A long shaft is connected to all the 12 presses by cogged gearing, and the shaft is belt driven, the power being developed by a steam engine.

Capacity of the Presses.—The 12 presses between them crush about 18 maunds of 82lbs. per day of 12 hours. Each press takes a charge of $7\frac{1}{2}$ seers and $1\frac{1}{2}$ hours is required to complete one crushing.

Yield of Oil.—According to the grade of mustard, the yield of oil per maund of seed crushed is 12—15 seers: *viz.*, 30—38 per cent.

Kazli seed gives from 12—13 seers and brown and yellow seed give $13\frac{1}{2}$—15 seers per maund, the yellow giving the highest yield of all.

Kinds of Seed pressed.—Three kinds of seed are used for pressing in the factory.

1. White or yellow. This is imported from Behar, Cawnpore and Delhi, there being very little grown locally. Cawnpore and Delhi is the best seed, the Punjab seed being considered the best of all. Behar seed is smaller than the seed from these two places.

2. Brown. The above remarks on the white and yellow seed hold *good* for this also.

3. Kazli. This is a small-grained brown seed and is grown in Purneah, Nadia, Jessore, Midnapore and Behar. Mostly the seed grown locally is used for crushing, but it is imported from Purneah if the price is favourable.

Rai is not pressed for oil as the grain is hard and it gives a low yield.

Marketing the Products. Oil.—This is sold at Rs. 16-8-0 to Rs. 17-0-0 per maund of 82lbs. and is all disposed of locally. It is used for cooking and illuminating, and also for anointing the body.

Cake.—This fetches from Re. 1-12-0 to Rs. 2-2-6 per maund of 82lbs., and is all sold in the neighbourhood. It is used for feeding cows and also for manuring. As a manure it is especially liked for the betel vine which is grown largely throughout Jessore. A large amount of mustard cake is imported from Calcutta for cattle-food, and a small proportion of this, perhaps 10 per cent., is used as a manure for the betel vine, and also for market garden crops occasionally.

Cost Price of Seed.—The price of mustard seed is regularly quoted in "Capital." Early in 1911 yellow seed was quoted at Rs. 5-8-0 to Rs. 6-8-0 per maund, and the brown at Rs. 5-9-0 to Rs. 5-14-0. Now however (November 1911) prices have gone up considerably, and such variations in price are likely to make all the difference between profit and loss in the undertaking.

Amount of Oil in the Seed.—Dr. Leather quotes numerous analyses of mustard seed. According to variety and district of origin, their oil-content varies from 30 - 48 per cent. The white or yellow varieties are generally highest in oil-content.

Composition of the Cake.—The accompanying analysis shews the composition of a sample, drawn by the writer from a stock of cake as it was being offered for sale at Kotchandpur:—

Moisture	12·52
Oil	10·04
Albuminoids	33·69
Carbohydrates	28·81
Woody fibre	10·58
× Sol. mineral matter	2·70
Sand	1·66
	100·00
Total Nitrogen	4·26
Containing Nitrogen	3·79
× Containing P_2O_5	2·18
Containing K_2O	1·26

We can only conclude that at the price at which this cake is sold, Re. 1-14-0 to Rs. 2-2-0 a maund, it is very good value both as a cattle food and as a manure.—(H. E. Annett.)

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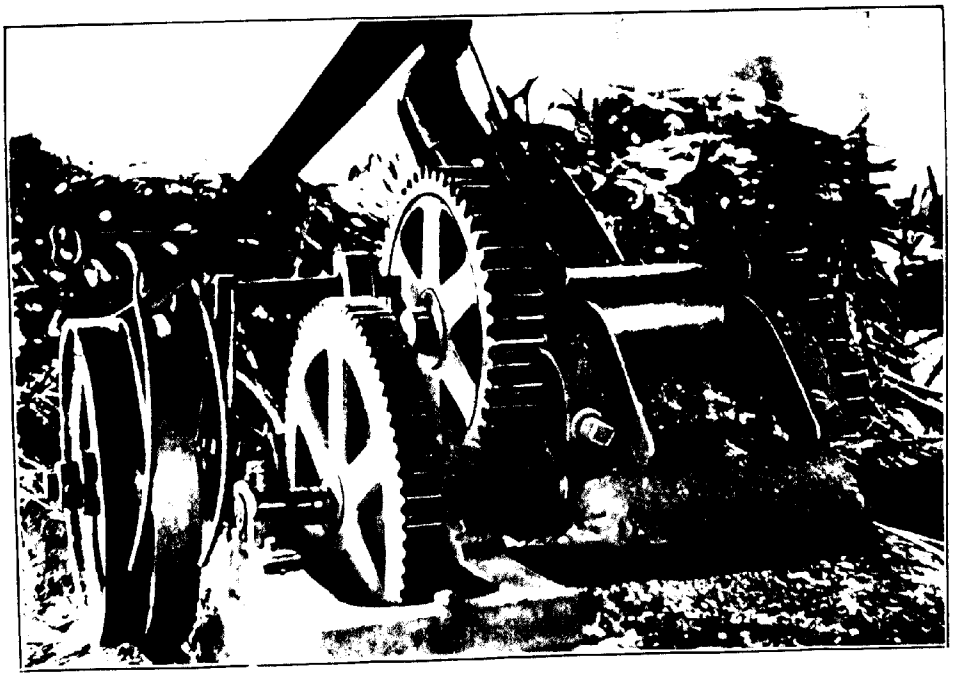
Cane Crushing by Power in Udumalpet Taluq, Coimbatore District.—The Committee, appointed at the Agricultural Conference held at Cawnpore in February 1907, to frame an outline of the general scheme for the improvement of the Sugar-cane Industry in India, in recommending the introduction of the small power factory system, suggested the trial of a small power factory as an experiment, at a suitable Sugar Experimental Station:* but the proposal does not appear to have advanced any further. In the Amravati Valley of Coimbatore District, M. R. Ry., Kaniyur Krishna Iyer Avl. has been cultivating about 50 acres of cane every year, and having experienced considerable difficulties in crushing his crop with the ordinary small iron mills driven by cattle, he invested in a steam engine of 10 H.P. and a power three roller mill 18" × 12" (Plate V) to crush his crop. By so doing he has been able to dispense with about 32 pairs of cattle and 8 ordinary mills. It would thus appear that the small power factory system recommended by the Board has already been in use in this part of the country, but instead of obtaining sugar directly from the juice, jaggery is made in the ordinary way, and this has been found very profitable. The writer's report on a tour made in this locality may be of interest:—

Mr. Krishna Iyer is the richest landlord in these parts, and he cultivates himself about 250 acres of wet† and dry lands in Kohemum and Komalingam, two adjoining villages in the Amravati Valley of Udumalpet Taluq. Here cane cultivation is of very recent introduction, and some 20 years back, there was no cane cultivation worth the name, yet there are over 200 acres

* Para. 17 of the Committee's Report.

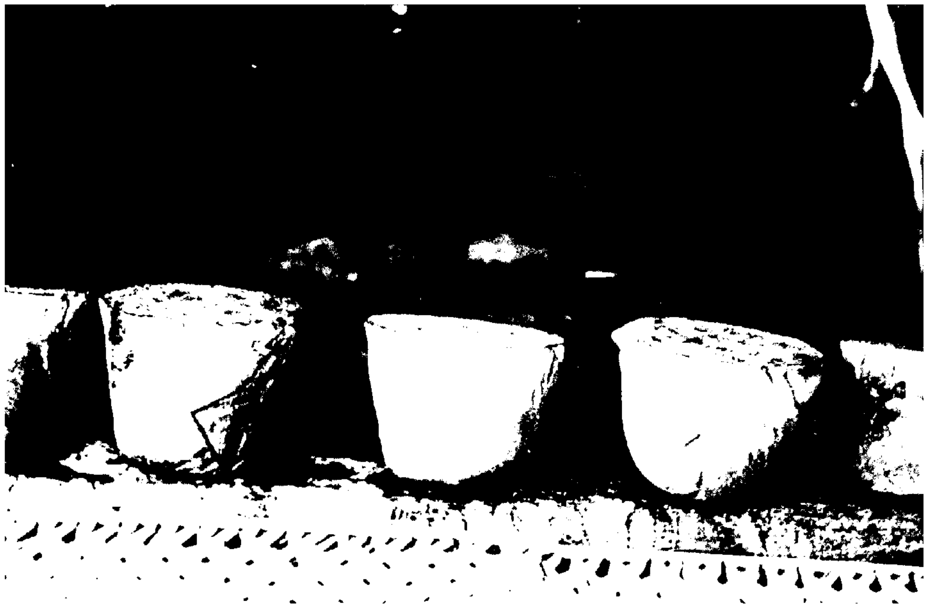
† Wet lands are commanded by irrigation channels and water is supplied for about six months in sufficient quantity to grow a crop of swamp paddy. For twelve months crops like cane, this must be supplemented by wells.

PLATE V.



THREE ROLLER MILL No. 12.

PLATE VI.



Moulded Jaggery for Export to Bombay.

now in this village. Most of the ryots are sinking wells in their wet lands at a cost of Rs. 200 to Rs. 300 to supplement the channel and tank irrigation and grow canes. The area is very rapidly increasing, and all the credit is due to the grandfather of this gentleman, who introduced cane cultivation into the village, if not into the Amravati Valley. In a single village of Budinatham there are more than 2,000 acres under cane, and the single Taluq of Udumalpet contributes nearly a third of the total cane area in the district.

The chief variety cultivated is Puvan, though Vellai is also found to some extent. Stray plants of Red, Nanam and Buthan canes are also found here and there. Here the pans are $5\frac{1}{2}$ feet in diameter, and are made of very thin sheet iron, costing only Rs. 14 to 16 each. These are largely made at Dharampuram and Udumalpet. No extra fuel is required for boiling the juice, as the trash and megass are found quite sufficient. The jaggery is made into big cylindrical moulds weighing 65 to 75 lbs. each (Plate VI), and exported to the Bombay Presidency. Gujerati merchants from Bombay and Ahmedabad enter into contracts with the ryots, and pay advances. There is no demand for small cubes as are made at Coimbatore. Holes are dug in the ground, a gunny or thick piece of cloth is spread inside, and the semi-solid boiled mass (from the receiving pan usually a wooden boat) is poured into them to harden. The next day the moulds are taken out of the holes. No great care is taken to remove the scum and improve the quality: a very small quantity of lime is added after the juice begins to boil. A pan is ready in two hours, and 6 to 7 pans are taken from 6 A.M. to 7 or 8 P.M. Each pan receives a charge of about 600 lbs. of juice from which 80 to 100 lbs. of jaggery is obtained. Two boilings generally make three moulds.

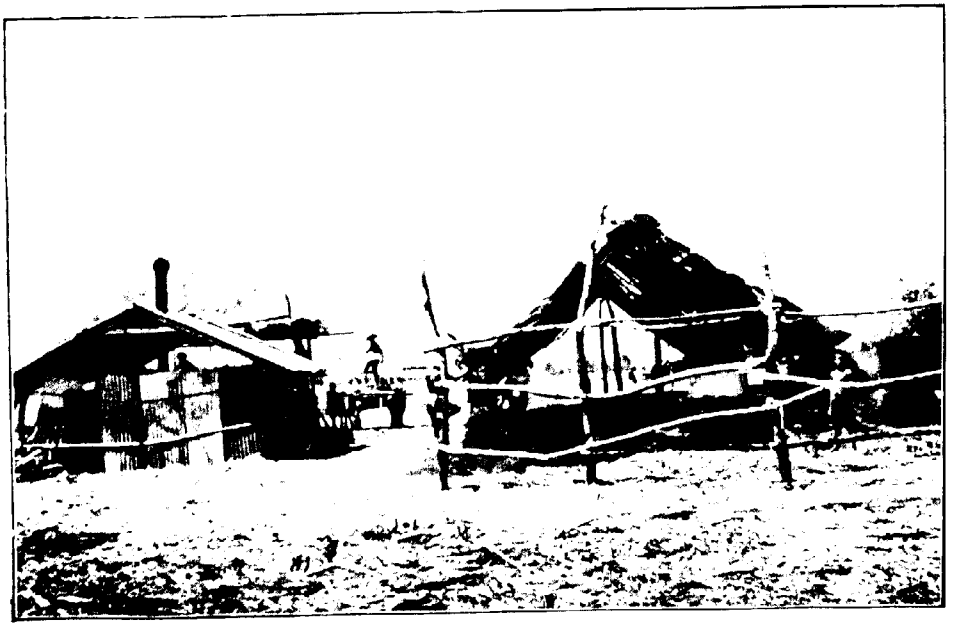
Mr. Krishna Iyer cultivates about 50 acres of cane every year, and the chief variety is *Vellai*. The crushing is done by a power mill with horizontal rollers, as already stated. The steam engine cost him about Rs. 5,000 and the mill Rs. 1,500. He works 8 hours a day, and this gives him sufficient juice to

keep 6 to 7 pans constantly going all through the day (6 A.M. to 8 P.M.). He crushes about half an acre a day, and it takes him 3 to 3½ months to finish his crop of 50 acres. Before he installed the engine, he was using a number of iron mills driven by cattle, as noted above, and he has now effected a considerable saving by crushing his canes by power. After seeing this, Mr. Venkata Krishna Iyer of the same village and Tirupati Naidu of Bodipatti have gone in for power mills, and they are now crushing their canes with the oil engines they have already got for lifting water. Apart from crushing the canes with a power mill, there is no other difference in the method of jaggery making. The juice is boiled in open pans as the other ryots do. He sent one of his men for training to Muradabad in the Hadi's process of sugar making, but he gave up the idea as he found jaggery making more profitable under the local conditions. He has got six fireplaces arranged as in the diagram (p. 107).

A general view of the engine shed and the boiling place is taken in (Plate VII) and of the boiling place separately in (Plate VIII). He has six fireplaces with one fireman to each. The writer has advised him to arrange them in the form of a battery over a common furnace as shown in Plate IX taken of a model made on the Central Farm. He has caught the idea and promised to construct one. The juice may be put into the top pan and gradually conducted to the lower ones by means of taps. There are two pans at the lowest level directly over the fire-pit where jaggery is made. Clarification is made in the first pans and when the bottom pans are ready they can be removed in turn and replaced after pouring the contents into receiving pans (wooden boats), so that the fire is continuously kept on.

He originally had no other work for the engine during the remaining part of the year. He has now got a rice huller and a tile-making machine, to provide work for the engine after the cane season. He cultivates canes only in the *Adi* season (July to August), but has been advised to have some area under *Maci* planting (March-April) also, whereby he can have work for

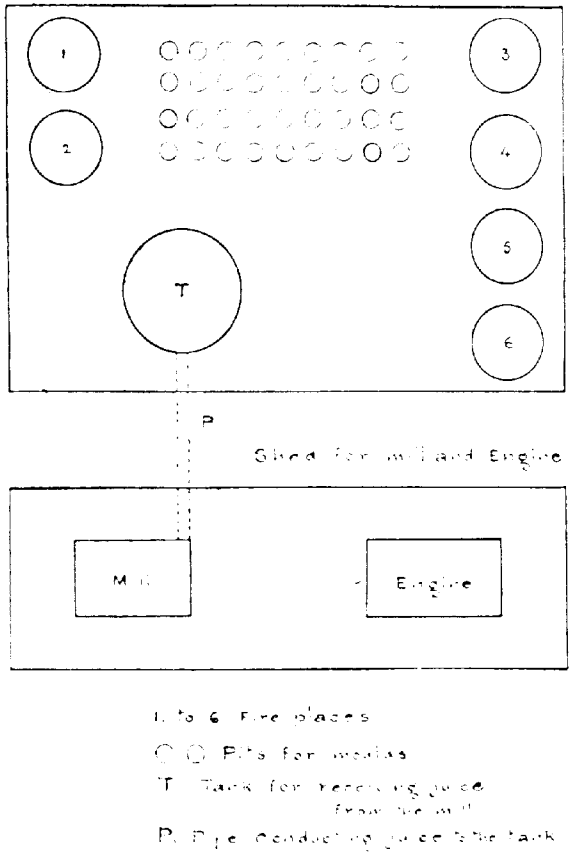
PLATE VII



I. J. I. GENERAL VIEW OF ENGINE AND BOILING SHED.

PLATE VIII

another 3 or 4 months in the hot weather, and he has promised to cultivate some acres of cane in the March season.



In Udumalpet Taluq several cultivators are improving their lands for cane cultivation, by carting silt at the rate of 2,500 cart loads per acre (Plate X), spread so thickly that the layer is about a foot thick: they then plant canes on the carted silt without any ploughing at all. This silting costs nearly Rs. 250 to 300 per acre, which is made good by the cane crop grown on it in the very same year.—(D. BALKRISHNAMURTI.)

EXPERIMENTS ON THE USE OF THE CENTRIFUGAL IN REFINING *Rab*.—When in Bareilly, U. P., in February 1910, the writer visited a Court of Wards Estate on which the Hadi process was in use for the preparation of *rab* from sugar-cane juice, the following notes taken from the writer's tour diary may be of some interest. There are a large number of villages under the Estate, and no difficulty is experienced in getting as much sugar-cane grown as required. The Estate had made a contract with the villagers, by which the latter agreed to supply juice at the rate of Rs. 32 per 100 maunds. This rate strikes one as distinctly unfavourable to the villagers since, assuming that the cane yields 55 per cent. of juice, the price for cane works out at Rs. 32 for 180 maunds, which is only 2·8 annas per maund. This is an extremely low figure, especially when the sellers had the additional labour and expense of crushing the cane. One is not surprised to learn therefore that eventually the Estate had to agree to give Rs. 40 and even Rs. 45 per 100 maunds of juice.

The villagers had to find their own mills. Two-roller iron mills were the ones most commonly in use, though a few had 3-roller mills but even these were of a very poor quality. The extraction of the juice was very badly done since an examination of the bagasse shewed it to be very juicy still and very little broken up. The mills were all hired by the villagers. For a 2-roller mill they were paying Rs. 8 for the season of about 3 months. These mills are said to cost only Rs. 30 to buy outright. For a 3-roller mill anything from Rs. 9-8-0 to Rs. 14 was being paid for the season, the original cost of which was under Rs. 40.

Having bought the juice, the Estate boiled it into *rab*, using the Hadi pans for boiling. The *rab* produced was of very fine quality. After it had been stored for 10 days or more, to enable crystallization to go on, it was carted to the Court of Wards refinery which is situated in Bareilly City. At the refinery the writer met Mr. Dickinson, representative of Messrs. Thomas Broadbent and Sons, who was carrying on some experiments there

PLATE IX

F. J. L. Model of Improved Furnace.

The factory possesses one belt-driven centrifugal, of the suspended "Weston" type, the basket of which is 30" in diameter and whose speed is 1,200 revolutions per minute. Steam power is used, and the cost of engine, boiler and centrifugal was about Rs. 3,000. The engine develops about 3½ H.-P. and the centrifugal requires about 2½ H. P. to run it, once it has started.

The *gharras* containing the *rab* were broken. The *rab* was seen to be a very hard mass and very uniform. It was put into a pug-mill and ground up. The pug-mill was placed over the basket of the centrifugal, so that by moving a slide at the bottom of the mill, *rab* could be run into the centrifugal. It has been found by experience just what depth of *rab* to run into the centrifugal, and the charge is generally about 2 maunds. About 12–15 seers of molasses are also placed in the basket, and the whole mixed up, otherwise the *rab* would not be fluid enough. On starting the centrifugal it has to be steadied by pressing two bamboo rods against the suspending rod. This steadying is necessary in order to get an even distribution of the *rab*. The molasses are all separated in from 15–30 minutes, depending on the season. Cleaning out and recharging takes 3–5 minutes. Towards the end of each run *ritha* (soap-nut) water is splashed round the inside of the basket. To give an idea of the daily work of the centrifugal it might be mentioned here that 10 maunds 24 seers of white sugar were turned out in one day, on February the 12th, 1910, but this outturn could be largely increased.

Products Obtained.

White sugar. This is spread in the sun on a white floor to dry. It is required to be as fine as possible. Absolutely white sugar is not liked in these parts because the people think it is foreign and clarified with animal charcoal.

Molasses. This may be either (i) sold to tobacco dealers to mix with tobacco, (ii) Boiled down to a hard mass, jaggery, and sold as a sweetmeat, (iii) Sold to spirit makers, or (iv) it may be more profitable to reboil to *rab* and centrifugalize again.

Thus a second crop of white sugar is obtained, and there are still molasses left over which, for the purposes of the tobacco trade, is just as good as before. Most of the first molasses in this factory are reboiled to *rab* which is again treated by the centrifugal.

By reboiling the molasses to *rab* and extracting a second crop of white sugar a very big profit is said to be made, as indicated by the figures set out below :—

Expenditure.	Rs.	A.	P.	Income.	Rs.	A.	P.
Value of 47 maunds of molasses ...	78	0	0				
2 boilers for two days at 6 annas per day each ...	1	8	0	9½ mds. sugar @ Rs. 9	87	8	0
1 fireman for 2 days ...	0	6	0				
Fuel	3	0	0	28½ mds. molasses @ ...	47	0	0
26 *ghurras* for *rab*	1	12	0				
Centrifugalling charges	10	0	0		132	8	0
	94	10	0				

This shows a profit of Rs. 37-14-0 on an outlay of Rs. 94-10-0, or roughly 40 per cent., though it must be remembered that nothing has been allowed for interest on capital.

In the writer's opinion a yield of 25 per cent. sugar from second *rab* is much too high and 17 per cent. would probably be much nearer the mark. But even this figure would still give a good profit from the undertaking. The rest of the figures appear to be very reasonable, the price at which he assumes white sugar to be sold (Rs. 9) being particularly low. If, however, there was any difficulty in disposing of molasses there would be not much chance of any profit.

Some careful trials had been carried out at the factory to find the percentage outturn of white sugar from *rab*. The details of three of these are here given. They were all carried out in the presence of Md. S. A. Beg, a member of the Subor-

---

* 2 days are required to boil down [illegible].

† *Rab* produces about 50 per cent. of its weight of molasses, hence by [illegible] from 47 [illegible] about 38 mds. of second *rab*; 38 mds. *rab* at 25 per cent. [illegible] 9½ mds. 50 per cent. of 28 mds. 20 srs. molasses.

PLATE X

E. J. C. VERY HEAVY DRESSING OF TANK SILT GIVEN TO CANE LANDS.

inate Agricultural Service of the United Provinces. The first wo were made in conjunction with Mr. Dickinson in the Court of Ward's Factory, and the third at a similar factory belonging to Jr. Raghunandan Pershad.

No. of Expt.	Date.	Wt. of *cah* purchased.	Wt. of juice expressed.	Density of *cah* in degrees.	Thickness of juice on sides of basket.		Density of juice in degrees.	Weight of sugar obtained.	Percentage of white sugar to *cah*.	Origin of *cah*.
					Inches.	Cm.				
		Mds. s.	Mds. s.					Mds. ch.		
1	11-2-10	2-0-1	0-14-0	5½°	2½"	1"	25	0-38-12	37·5	Sohas Pilibhit.
2	10-2-10	1-20-0	not recorded	not recorded	not recorded	not recorded	21	0-25-0	41·5	Do.
3	12-2-10	2-0-0	0-15-0	5°	2"	1"	22	0-30-10	37·5	Gora village near Seraimow.

Experiment No. 1 gave an especially high figure but the experiments were all most carefully carried out.

The following was an experiment on a much larger scale. It was carried out at the Court of Ward's Factory.

The outturn of white sugar from 39 maunds 21 seers of *cah* was carefully weighed and found to be 16 maunds 21 seers or 42 per cent. The production of this amount of white sugar ran into two days. (H. E. ANNETT.)

SALIX CAPREA, *Linn.*—VERN. BEDMUSHK.—Natural order Salicineæ.—Flora British India, Vol. V. page 629.—It grows to a tree 25-30 feet, flowers before leafing, trunk attains 3-4 feet girth, but is often a shrub. The leaves 2-4 inches are elliptic, oblong, dark green above and margins often recurved, base cuneate rounded or cordate.

* Footnote illegible

Habitat.—This important plant of the willow family is said to have been introduced into the Punjab from Kashmir, and is now grown in abundance in the gardens in the vicinity of Lahore, and is also found in Peshawar. There is a regular cultivation of it in Lahore, on account of its yellowish fragrant flower, from which scented water and perfumeries like *attar* are manufactured by the native druggists of Lahore and Amritsar.

Propagation by Cuttings.—It is generally propagated by cuttings, during the months of January and February. These are planted close in rows, and watered once or twice a week until shoots appear. After this, watering is done at comparatively longer intervals, according to necessity.

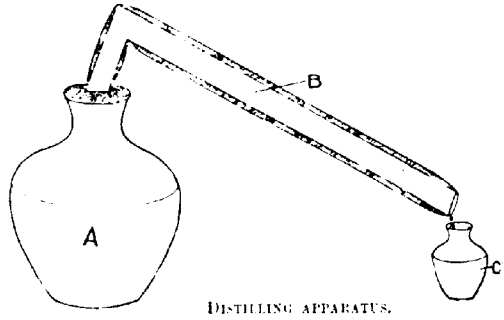
Transplantation.—When cuttings are a year or two years old, they are transplanted to land previously prepared for the purpose. They are planted in clumps of 4 or 5 cuttings close together in one place. The season of transplantation is the same as that of planting the cuttings.

Flowering Season.—It flowers only once in a year in the months of February to March, and the flowering season lasts for about a fortnight only, during which the flowers are gathered and brought fresh to the Lahore market for sale. They are generally sold at the rate of Rs. 20 to 30 per maund, but sometimes at higher rates according to the state of supply and demand. To ensure a safe supply of the flowers, some of the well-known native druggists of Lahore sometimes have to make contracts beforehand with the owners of the plants. Unlike the rose, this flower loses its fragrance and becomes useless, say after 10 or 12 hours from the time of plucking, and therefore fresh flowers are required for distillation.

Manufacture of Scented Water.—In the Punjab the scented water of this flower is distilled in Amritsar on a very small scale, but in Lahore there is a regular industry. It is distilled according to the process as given below :—

A copper vessel marked A in the figure, tinned inside, is partly filled with water, into which the fresh flower is thrown. To obtain one maund of scented water, one maund of flowers must be distilled

with one and a half maunds of water. The mouth of the vessel A, is closed with a copper or earthen cover, air-tight, to



DISTILLING APPARATUS.

the middle of which is attached a bent tube B, usually of bamboo, tightly wrapped up with string and plastered over with *Multani* earth. The cover of the vessel A is also plastered over with wheat flour or *Multani* earth to make it air-tight. The vessel A is then put on a slow fire and allowed to remain on the stove for several hours, during which the fragrant essence of the flower passes through the tube B in the form of vapour and deposits as liquid in a pot C kept just beneath the other end of the tube. It is said that in 6 to 8 hours about one maund of scented water can be distilled. The scented water thus prepared is always kept in a cool place, in well-corked bottles or copper pitchers, the mouths being closed tightly and plastered over.

Process of preparing Attar.—The *attar* of this flower is obtained by the following process:—

A quantity of sandal oil is put into the pot C, which receives the scented distilled water from the tube B as described above. To obtain, for instance, one seer of *attar* of medium quality at one rupee per tola, 2 maunds of flowers are required. The distillation may be continued for 3 or 4 days in succession, distilling say half a maund of flowers each day. After each distillation the sandal oil is separated from the water by skimming, and is replaced into the pot C for the next distillation, and this is repeated until two maunds of flowers are distilled. It should

from the sandal oil is not rejected, but used with the water to be employed for the next distillation. The sandal oil, through contact with the scented water, absorbs the scent, and thus the *attar* is prepared. This *attar* is not in much demand in the Punjab, but is exported to Calcutta, Gwalior, Allahabad, Hyderabad, and other places, where it is highly valued and used by the natives. It is sold at Re. 1 to Rs. 2 a tola, according to quality.

The distilled scented water is used in cases of fever, as a febrifuge, by native physicians, and is also considered to be a blood purifier. In Lahore, there is scarcely a single household that does not purchase a bottle or two of this distilled water during the summer, for natives generally take it with *Sharbat*, as a cooling beverage. It is renowned for the cooling effect, and much prized by the natives. It is sold from 10 annas to 14 annas a bottle according to quality. If distilled water is not available, native physicians prescribe a decoction of the leaves according to the process described above.—(K. BANERJEE.)

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SECOND INTERNATIONAL CONGRESS OF ENTOMOLOGY.—The Second International Congress of Entomology will be held at Oxford from August 5th to 10th, 1912. Further particulars will be announced shortly.

The Executive Committee proposes to find for members of the Congress lodgings in the town, or rooms in one or more of the Colleges at a moderate charge; rooms in College will be available only for men.

The Executive Committee invites an early provisional notice of intention to join the Congress, in order to be able to make the arrangements for the necessary accommodation.

The proceedings of the First Congress are in the press and will be published shortly.

All communications and enquiries should be addressed to the General Secretary of the Executive Committee.

MALCOLM BURR,

c/o The Entomological Society of London,

11, Chandos Street, Cavendish Sq., London, W.

REVIEWS.

Bollettino del Laboratorio di Zoologia Generale e Agraria della R. Scuola Superiore d'Agricoltura in Portici. Volume V, p. 352, 1 double plate and 174 text-figures, 1911. (Price, 20 Lire.)

The fifth volume of this Bulletin, issued in August 1911, continues the useful record of work in Economic Entomology carried out by the Portici School of Agriculture. The twenty-four separate papers which it contains are not, however, limited in their scope to topics of purely local interest, but include accounts of insects from almost all parts of the world; North America, Mexico and Argentina, Europe and South Africa, India, Ceylon, Java, New Guinea and Australia, all contribute their quota of interesting facts about insects. This is as it should be. We are too apt to concern ourselves solely about our own special local problems, oblivious of the work being done elsewhere, whereas a knowledge of affairs beyond our borders is often of as great importance, particularly in these days of rapid transport.

The present volume opens with a review of a section of the Fruit Flies: the Baluchistan Melon Fly is made the type of a new genus, *Myiopardalina*, Bezzi, and *Carpomyia vesuviana* is recorded as Indian, apparently for the first time, on the strength of a specimen in the Indian Museum reared at Calcutta from Ber Fruit. Other articles include descriptions of new apterous insects (*Machilida*) from India and Ceylon, a paper on North American Galls, a further instalment on Italian Chalcids, several papers on some of the extraordinary insects and mites which are found as guests in nests of ants and termites, a descriptive life-history of a new *Aleurodes* living on the olive, an account of a

collection of Scale-insects from Argentina, etc. The accounts given of two insect pests of the Cabbage, *Aphis brassicæ* and *Plusia gamma*, deserve special mention: not only are the appearance and habits of the insects themselves fully described and clearly illustrated, but the various parasites which attack them and keep them in check are also carefully described and figured, and in many cases also the hyper-parasites which prey on the parasites, so that it is possible to form some real idea of the conditions under which these insects live and of the complex relationships which they bear to one another. It need hardly be added that there is ample scope in India for a similar complete investigation of the bionomics of even our very commonest insects.—(T. B. F.)

***

GOLLAN'S INDIAN VEGETABLE GARDEN.—A third edition of this little book is published by Messrs. THACKER, SPINK & Co.: price, Rs. 2. It contains useful hints on the cultivation of vegetables in India—somewhat fuller than are to be found in most Indian gardening books—as well as short notes on the cultivation of annual flowers.—(A. C. D.)

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FAUNA OF BRITISH INDIA.—In the "Fauna of British India" Series the *Fresh-water Sponges and Polyzoa and Hydrida* by Dr. N. Annandale has just been published. Canon W. W. Fowler's volume on the *Cicindelida* and *Paussida*, with a General Introduction to the *Coleoptera* and Mr. E. Brunetti's work on the *Nemocera* (excluding the *Chironomida* and the *Culicida*) are in the press.

The remaining volumes which the Editor, Mr. A. E. Shipley, with the assistance of Mr. Guy A. K. Marshall, and with the sanction of the Secretary of State for India, has arranged for in this series are:—

Volumes on the *Orthoptera* (*Acrididæ* and *Locustidæ*) by Mr. W. F. Kirby; on *Butterflies* (*Lycænidæ* and *Hesperiidæ*) by Mr. H. H. Druce; on the *Curculionidæ* by Mr. G. A. K.

Marshall; on the *Ichneumonida* by Mr. Claude Morley; on the *Longicorn Beetles* by Mr. C. J. Gahan; on the *Blattidæ* by Mr. R. Shelford; on the *Helicida* by Lieut.-Colonel H. H. Godwin-Austen; on the *Ixodida* and *Argasida* by Mr C. Warburton; on *Leeches* by Mr. W. A. Harding; on the *Meloida* by Professor Creighton Wellman; on the *Brachyurous Crustacea* by Lieut.-Colonel A. Alcock, M.D.; and on the *Unionida* by Mr. H. B. Preston.

CROSS-FERTILIZATION IN THE SUGARCANE.—This subject has been discussed in detail in a recent issue of the Proceedings of the Java Sugar Experiment Station.* The matter is of particular interest to India at the present time, in view of the proposals which have been put forward to start a cane-breeding and acclimatisation station in Madras, in connection with the improvement of the sugar industry. It has been found, in Java, that moisture is required for the flowers of the sugar cane to open, and that arrows which are at all dried up do not flower. The flowers begin to open in the very early morning, and this goes on up to 8 A.M. The first flowers produced are generally the most vigorous. Varieties with infertile pollen can be detected by means of the iodine test. If starch is absent from the pollen grains, they are infertile, while its presence denotes the opposite condition. Various methods of obtaining cross-fertilized seeds in large numbers are described by the authors, and, in conclusion, they give an account of the way in which the seedlings are raised. The paper, which is illustrated and which contains a list of recent literature, is a valuable addition to this subject. (A. H.)

* *

A MANUAL OF PHILIPPINE SILK CULTURE. By CHARLES S. BANKS. BUREAU OF SCIENCE, MANILA: 1911. PP. 48: 20 Plates. (Price not stated.)

As its title indicates, this is a brief handbook for the guidance of those desirous of taking up sericulture in the Philippines.

* Willbink and Toxopeus—*Mededeel. van het Proefstation voor de Java-Suikerindustrie*, No. 6, 1911.

The Mulberry Silkworm is treated of at some length. Japanese univoltine (here called monovoltine) silkworms were found unsuitable and the eggs failed to hatch unless kept in cold storage.

Bengal-Ceylon multivoltine races have been found more satisfactory, and yield nine crops in the year, in the equable warm climate of Manila. A stable multivoltine mongrel, between the Japanese univoltine white-cocoon silkworm, and the Bengal-Ceylon multivoltine golden-yellow-cocoon silkworm, is stated to have been established, having been reaerd for more than twenty-five generations: the cocoon produced by this mongrel is white, and the quality of the silk is said to be "equal to that of the best Italian or Japanese varieties when reeled in conformity with silk standards and in proper skeins."

Three pages and four Plates are devoted to a short account of the Eri Silkworm, but the author does not seem very enthusiastic over the outlook for this species in the Philippines, although the castor plant is stated to grow as a weed everywhere and to produce a luxuriance of leaf.

Of the wild silkworms found in the Islands, two are identical with common Indian species, but none seem promising from the point of view of commercial sericulture.

It is interesting to note the author's claim that no infectious disease of silkworms is known in the Philippines, and, in this connection, it may be added that the importation, except by the Bureau of Science, into these Islands, of silkworms in any stage, is prohibited by law, the object of this measure being to eliminate any chance of introducing silkworm diseases from abroad.

Hints and Notes on the silkworm house and appliances, the cultivation and propagation of mulberry trees, the selection of cocoons for reproduction, the preparation of silk, and the silk trade of the Philippines, conclude an interesting pamphlet, which should prove useful to intelligent cultivators and others desirous of taking up sericulture. A very useful index of three pages provides a summary of the contents of the 43 pages actually devoted to the discussion of silk culture.—(T. B. F.)

PUBLICATIONS OF THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA.

[To be had from Messrs. THACKER, SPINK & CO., Calcutta.]

Annual Report of the Imperial Department of Agriculture in India for the year 1904-05. Price, As. 12 or 1s. 2d.

Report of the Imperial Department of Agriculture in India for the years 1905-06 and 1906-07. Price, As. 6 or 7d.

Report of the Agricultural Research Institute and College, Pusa, including Report of the Imperial Cotton Specialist for the years 1907-08. Price, As. 4.

Report of the Agricultural Research Institute and College, Pusa, including Report of the Imperial Cotton Specialist for the year 1909-10. Price, As. 4 or 5d.

Report of the Agricultural Research Institute and College, Pusa (including Report of the Imperial Cotton Specialist) 1910-11. Price, As. 6 or 7d.

Report on the Progress of Agriculture in India for the years 1907-09. Price, As. 6 or 7d.

Report on the Progress of Agriculture in India for the year 1909-10. Price, As. 6 or 7d.

Report on the Progress of Agriculture in India for 1910-11. *(In the Press.)*

Proceedings of the Board of Agriculture in India, held at Pusa on the 6th January 1905 and following days (with Appendices). Price, As. 8 or 9d.

Proceedings of the Board of Agriculture in India, held at Pusa on the 15th January 1906 and following days (with Appendices). Price, As. 12 or 1s. 2d.

Proceedings of the Board of Agriculture in India, held at Cawnpur on the 18th February 1907 and following days (with Appendices). Price, Re. 1-2 or 1s. 6d.

Proceedings of the Board of Agriculture in India, held at Pusa on the 17th February 1908 and following days (with Appendices). Price, As. 8 or 9d.

Proceedings of the Board of Agriculture in India, held at Nagpur on the 15th February 1909 and following days (with Appendices). Price, As. 8 or 9d.

Proceedings of the Board of Agriculture in India, held at Pusa on the 21st February 1910 and following days (with Appendices). Price, As. 8 or 9d.

Proceedings of the Board of Agriculture in India held at Pusa on the 20th November 1911, and following days (with Appendices). *(In the Press.)*

Standard Curriculum for Provincial Agricultural Colleges as recommended by the Board of Agriculture, 1908. Price, As. 4 or 5d.

The "*Agricultural Journal of India*." A Quarterly Journal dealing with subjects connected with field and garden crops, economic plants and fruits, soils, manures, methods of cultivation, irrigation, climatic conditions, insect pests, fungus diseases, co-operative credit, agricultural cattle, farm implements and other agricultural matters in India. Illustrations, including coloured plates, form a prominent feature of the Journal. It is edited by the Inspector General of Agriculture in India, assisted by an Advisory Committee of the staff of the Agricultural Research Institute, Pusa. *Annual Subscription*, Rs. 6 or 8s.; Single copy, Rs. 2.

Memoirs of the Department of Agriculture in India are issued from time to time as matter is available, in separate series, such as Chemistry, Botany, Entomology and the like.

BOTANICAL SERIES.

Vol. I, No. 1. Studies in Root Parasitism. The Haustorium of Santalum Album—Part I.—Early Stages by C. A. Barber, M.A., F.L.S. Price, Re. 1.

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Vol. I, No. IV. *Gossypium Obtusifolium*, Roxburgh, by I. H. BURKILL, M.A. Price, Re. 1

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